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ABSTRACT

A wide variety of environmental careers, their educational requirements, places of employment, growth and future potential are examined. A discussion of the new environmental era characterized by a joining of environmental education, science, and management in an interdisciplinary, integrated, and involved approach to environmental concerns forms a background for the investigation into different careers. Representative environmental studies programs at a range of colleges and universities are described. Careers in science, environmental health, resources and recreation, and land use and human settlements are discussed. Comments indicate that scientists and engineers are most in demand but non-science specialists and generalists are in growing demand. Appendices provide resource information about citizen organizations, publications, and federal agencies. (DC)

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OPPORTUNITIES IN ENVIRONMENTAL CAREERS

Odom Fanning

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OPPORTUNITIES IN **ENVIRONMENTAL CAREERS**

Odom Fanning

VGM Career Horizons
A Division of National Textbook Company
8259 Niles Center Road, Skokie, Illinois 60077

This book is dedicated to Carol and Kay,
to all of their generation
and to its environment.

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ABOUT THE AUTHOR

Odom Fanning is a Washington-based, freelance science writer and editorial consultant. *Career World* magazine has called him "the nation's leading expert in environmental and energy careers." The National Association for Environmental Education awarded him its Citation of Merit for his "contributions to appreciation and understanding of the environment," citing in particular "his hallmark book *Opportunities in Environmental Careers*." This Third Edition, Revised, is the tenth printing since first publication—on Earth Day, 1971.

Fanning is a graduate of Emory University and formerly was science reporter for the Atlanta *Journal*. He is a fellow of the American Association for the Advancement of Science.

The author also was editor-in-chief of *Environmental Quality: The First Annual Report of the Council on Environmental Quality*. His other books include *Opportunities in Oceanographic Careers*, an earlier VGM Career Horizons volume; *Man and His Environment: Citizen Action*, a college textbook published by Harper & Row; and *The Disease Detectives of CDC*, which he is writing for the Julian Messner division of Simon & Schuster. His articles and reviews have been published in *Audubon*, *Catalyst*, *Columbia Journalism Review*, *Defenders*, *Environment*, *Saturday Review*, *Sierra*, *Smithsonian*, The Washington *Post*, and The Washington *Star*.

Overleaf: Interested in an environmental job? Then there's good news for you in headlines such as these. But first, it takes education, lots of it and the right kind. Then, experience.

Biologist
PROJECT BIOLOGIST
Marine Biology
BACTERIOLOGIST
CHEMIST
SENIOR PLANT SCIENTIST
SPECIALIST
Professionals
Plant Physiologist
Sanitary Engineers
HAZARDOUS WASTE MANAGEMENT
OCCUPATIONAL HEALTH
MATHEMATICS
REERS WITHOUT LIMITS
NVIRONMENTAL QUALITY
CIVIL ENGINEERS
SENIOR EPIDEMIOLOGIST
ENVIRONMENTAL HEALTH
SANITARY ENGINEERS
RADIATION PROTECTION
ENVIRONMENT/ PROTECTION
ACOUSTICS—
NOISE ABATEMENT
Veterinarian
Environmental Science
CHEMICAL WASTE SPECIALIST
RPORATE SAFETY
ONMENTAL AFFAIRS
ENVIRONMENTAL CONSULTANTS
THERAPEUTIC RECREATIONIST
AQUACULTURE
Integrated pest management
GROUND-WATER HYDROLOGIST
ENVIRONMENTAL PLANNER
Highway Engineers
URBAN PLANNERS
Construct Administration
LEGAL COUNSEL
ECONOMISTS—MARKET RESEARCH
ENVIRONMENTAL CONSULTING
EXTENSION ASSOCIATE/ MARINE EDUCATION
SOCIOLOGIST
UTILITIES MARKETING
ART DIRECTOR
Wanted:
Secretary
Want To Improve Your Environment
TOXIC SUBSTANCES
Environmental Analyst

PREFACE TO THE THIRD EDITION

With the possible exception of energy, no field is more avidly seeking qualified personnel today than some professions of environmental management. It appears that this trend will continue for at least another decade. That's good news for you, if you're interested in an environmental career. First, however, you must prepare yourself to meet the stringent requirements of this new and exciting field. With proper qualifications, you can get an interesting job. With diligence, you can advance as rapidly as your talent and skills permit. With experience, in a few years you might be eligible for a senior environmental management position. Then you can take your pick of challenging jobs such as those represented in the headlines on the opposite page. All of those recruitment advertisements—and thousands more, offering tens of thousands of jobs—appeared recently in metropolitan newspapers.

In the 1960s you would have had a hard time finding even one such ad. The demand for environmentalists, which began around the time of Earth Day in the spring of 1970, has never ceased. New federal laws and regulations have created hundreds of permanent public-sector programs at the federal, state, and local levels. Every major company has established a department of environmental management, frequently headed by a vice president. It is usually responsible for complying with those legal requirements.

It is frequently concerned with lobbying for their repeal or modification. And it may be technically oriented and operated in conjunction with the company's environmental research, development, and technical services. In the large, multi-national corporations, several thousand employees may be involved in environmental activities. Most large trade associations have set up offices of environmental affairs, to advise and assist their member companies. Many consulting-engineering, management, and law firms specialize in providing services relating to the environmental problems of their clients.

Science and technology are at the heart of such activities, so, not surprisingly, scientists and engineers are the specialists most in demand for environmental jobs. The impetus for employment in the largest sector with the greatest public and private expenditures, employing about half of all environmental professionals, is the protection of human health. But, increasingly, people recognize that environmental problems cut across disciplinary lines and involve social and behavioral sciences, economics, and even aesthetic and cultural values. In addition to scientists and engineers, a wide range of non-science specialists and generalists is in growing demand. Among them are administrators, artists, computer scientists, economists, historians, journalists, librarians, sales and marketing executives, statisticians, and others.

Although it is impossible to measure precisely, one of the largest categories of these new environmentalists is the field of environmental impact assessment. Thousands of specialists and generalists are required to study the environmental implications of governmental and industrial actions. An interesting, smaller field is that of environmental mediation, the resolution of conflicts arising with respect to environmental values. And as a consequence of the new environmentalism, the specialty of environmental law is well established.

In this third edition, as in the previous two, we explore the routes which could lead to exciting new environmental horizons.

We describe representative environmental studies programs at a range of colleges and universities. We distinguish which professions require a bachelor's, master's, or doctoral degree. We indicate which offer superior growth potential. And for each of two dozen major environmental professions we ask, and answer, three questions:

- What education would you need?
- Where would you work?
- What is the job future?

Finally, we examine two periods for which environmental employment is reasonably well established–the mid-1970s and the mid-1980s–and project present trends into the future, namely to the mid-1990s.

Odom Fanning
Bethesda, MD

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Overleaf: Bumper-to-bumper traffic on the freeway is a familiar sight and, too often, a frustrating experience in every city. Photo: EPA-DOCUMERICA, Gene Daniels.

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CHAPTER 1

ENVIRONMENTAL HORIZONS, CLEAN AND CLEAR

> The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment.—The National Environmental Policy Act of 1969

What single invention means the most to you? Which product of human ingenuity, design, manufacturing, marketing and advertising skills most affects your lifestyle? What is the one thing you yearn for most (if you do not already have one), treasure highest (if you do have one), and pamper and polish with greatest satisfaction? What is the most pleasurable, most practical, most essential, and most expensive investment (other than a house) that most people ever own?

If you answered the automobile, you answered correctly. The automobile symbolizes some of the best features of our society and some of the worst. It changed the United States from a rural society to an urban and suburban one. It distinguishes a developed nation from a developing one. It provides jobs and, too often, unemployment.

We certainly would not—could not—give up the automobile. We require it for transportation and convenience even at the expense of congestion and pollution. We enjoy it for speed and freedom even at the risk of injury and death. The automobile

characterizes our modern, high-technology society at its best (benefits); and it symbolizes it at its worst (costs).

The automobile can neither be credited with, nor blamed for, any of its characteristics. It is a product of human innovation, and humans, all of us, determine how it is used or abused.

THE NEW ENVIRONMENTAL ERA

In recent years—especially since Rachel Carson's *Silent Spring* was published in 1962—there has been an increasing awareness that technology and growth were doing much damage to our environment. Young persons, in particular, became aware of and aroused over pollution, blight, deterioration, waste, and destruction of our natural valuables, and over the terrible hurt to everybody's health. Late in the 1960s, the media began to catalyze public opinion behind a change in political policies. Then, on January 28, 1969, a gigantic oilspill occurred offshore at Santa Barbara, CA. The dramatic television pictures of seabirds, their feathers coated with oily gunk, suffering and dying while people who cared tried to rescue them, symbolized all forms of technology's conflict with the environment. Capturing the national attention, that single event galvanized the public into action.

The public health movement was two and one-half centuries old, and the conservation movement one century old, at the time. Environmental stewardship was entrenched in our American value system. But most observers credit that catastrophe on the California coast with marking the start of the *new* environmental era. Modest organization work to promote the cause of the environment continued for the next year. Then, the following April of 1970, an estimated 20 million Americans participated in the first Earth Day, a more-or-less spontaneous, unexpectedly successful celebration.

Concurrently, a great deal of political groundwork was being laid. Through a rare combination of imagination, political leader-

ship, and luck, the Congress produced a gem of a law in the National Environmental Policy Act of 1969 (NEPA, for short). It was full enough of rhetoric to satisfy the most ardent Earth Day demonstrator. Every law has its rhetoric, but NEPA had more: a strong action-forcing device. Its Section 102(2)(c) requires an environmental impact statement in advance of any federal action that might significantly affect the quality of the environment. This requirement has revolutionized U.S., even international, decision making. It asks federal agencies: "Wait! Do we know all we should know about what you propose to do? Do we understand its consequences? Can we make it safer for people and more benign for the environment?"

If such questions had been asked—and if the technology had existed to answer them—Los Angeles might have been built so as to minimize its smog and traffic congestion. The automobile might have been developed so as to avoid harmful emissions. Certainly hazardous and toxic chemicals would not have been dumped in thousands of locations, from which they provably cause illness, and probably cause much of the rising incidence of cancer, miscarriages, birth defects, mental retardation, and other serious threats to health and life.

We may not be able to do much about the chemical estate we have inherited from previous generations. But we can unburden future generations by not making similar mistakes in our own uses of technology. The major social movement which offers the potential for stepping back, taking a second look, and making more rational social, political, and technological decisions is what we call *the new environmentalism*.

THE NEW ENVIRONMENTALISM

The new environmentalism has three facets: education, science, and management. It employs them in new ways. Contrast the old with the new as follows:

Education. Until very recently, environmental education at the college level meant pursuing a narrow discipline. One could become an engineer, moreover a chemical, civil, electrical, or mechanical engineer; but even the sanitary engineer, trained to manipulate environmental conditions which had impacts on society, was narrowly restricted to traditional technique. Social and environmental consequences were the concerns of others.

In 1969 an arm of the Congress surveyed all colleges and universities of the United States, to determine the nature and extent of their environmental curricula; 1300 responded. Of that number, only forty-five—less than 4 percent—reported having any undergraduate environmental studies other than disciplinary science and engineering.

Yet, within a year of Earth Day, our educational institutions were racing one another to provide the environmental courses students were demanding. The author's studies indicate that, today, at least half of the nation's 3000 colleges and universities offer broad, interdisciplinary environmental studies curricula! In the estimation of two veteran environmental educators:

> Barring English composition and math, few university subjects are being offered today in so many diverse ways and places, by such a mixture of schools, departments, and professors, as . . . environmental studies.[1]

Science. The new environmentalism also embraces environmental science. Traditionally, scientists and engineers worked on narrow disciplinary problems such as those having to do with climate, air turbulence, estuaries, forests, epidemics, earthquakes, and groundwater, to name a few. Beginning about 1970, environmental scientists broadened their perspective in response to governmental

[1] Clay Schoenfeld and John Disinger, eds., *Environmental Education in Action-II: Case Studies of Environmental Studies Programs in Colleges and Universities Today* (Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education, 1978), p.8.

support for interdisciplinary research and development and education programs.

There was probably another subtle reason for this broadening, too. New technology such as high-speed computers relieved scientists of much of the drudgery which long had characterized their work. Machines could handle vast amounts of data with the speed of light. Scientists could devote their time to things that were more "fun," one of which was interacting with fellow scientists in a teamwork approach to more broad-based environmental problems. For the first time, they could think in terms of "managing" or manipulating environmental phenomena, as easily as they could conduct scientific experiments in the laboratory.

Management. Environmental management is an action term, which refers to all activities, public and private, undertaken to achieve the goals of environmental quality. In such activities lie many jobs and careers. This is the author's definition:

> Environmental management is an interdisciplinary, integrated effort, involved with the very fabric of peoples' lives, and focused on a variety of interrelated environmental problems.

THE CHAIN OF "I'S"

Note, in the definition, the "chain of I's": *interdisciplinary/integrated/involved.* Take each link:

Interdisciplinary. Environmental education, science, and management are joined, each to the other. People formerly felt that it would be sufficient for one discipline to be joined to only one or two more. Now we know that all disciplines must be joined to all others, in an interdisciplinary team providing a collective Renaissance capability.

Integrated means a part incorporated into a larger whole. To the sciences must be added such other disciplines as engineering, business management and public administration, communications, economics, education, the humanities, law, philosophy, political

science, sales and marketing, and the social sciences. Here the Renaissance team becomes institutionalized (unfortunately, too often, depersonalized, as well).

Involved in the very fabric of peoples' lives and environments. Environmental education, science, and management are problem focused (concerned with ends) more often than discipline focused (concerned with means). Students and professional practitioners must be involved with all types of people, not just those of their normal class, in suburbia, in church or synagogue, or on the college campus. They must be involved, in addition, with the poor, the minority, the non-English speaking, the very young and very old, the physically handicapped, and those in the restricted environments of hospitals, slums, and prisons.

The chain of "I's" distinguishes the new environmentalism from the conservation ethic which is its heritage.

WHAT TYPES OF QUESTIONS ARE ANSWERED ON THE FOLLOWING PAGES?

1. Is the Environmental Studies degree marketable? (Page 19)
2. What are some environmental fields you could enter with the bachelor's degree? (Pages 19, 68)
3. What is ecology and what do ecologists do? (Pages 24-25)
4. How is biology like other sciences? (Page 28)
5. What are the advantages in alternate periods of work and college study? (Page 31)
6. What kind of environmental scientist might roam the earth collecting plants, and why? Might other kinds of environmental scientists also collect plants for other purposes? (Page 36)
7. What are the estimated benefits of clean air and water? (Page 43)
8. Why is acid rain an international environmental problem? (Pages 44-45)

9. What are some of the opportunities for environmental engineers overseas? (Page 51)
10. What major disciplines are new in this edition? (Pages 34, 60, 62, 84, and 126)
11. Can you name the four Environmental Health professionals who are licensed to treat patients? (Page 55)
12. Which professions in Environmental Health can be practiced with only the bachelor's degree? (Pages 69-77)
    Which in Resources and Recreation? (Pages 81-117)
    Which in Land Use and Human Settlements? (Pages 133-135)
13. Why do categorical specialities offer opportunities for graduates of Environmental Studies programs? (Pages 76-77)
14. What evidence is there as to how Americans feel about their natural heritage? (Page 82)
15. How many of the thirteen principal disciplines in Agricultural Sciences can you name? (Pages 86-88)
16. What factors could explain the expected continued growth in job demand for graduates in Agricultural Sciences? (Page 92)
17. Which Conservation professions employ the largest numbers of paraprofessionals? (Pages 99, 116)
18. In which environmental field is experience in a youth group such as an outdoor camp most likely to be directly applicable? (Page 103)
19. Which environmental field usually needs volunteers to work around animals? (Page 114)
20. What are some of the conflicts that arise in Land Use control? (Pages 120-121)

Overleaf: Interdisciplinary environmental studies at Allegheny College, Meadville, PA—and hundreds of other colleges and universities—involve lectures, labs, and field work. Photo: Allegheny College.

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CHAPTER 2

EDUCATION FOR THE NEW ENVIRONMENTALISM

> Today, no self-respecting campus is without some gesture toward environmentalism, and the more substantive enterprises represent a major departure in university focus and format toward interdisciplinary, multi-function, problem-oriented teaching, research, and outreach.–Clay Schoenfeld and John Disinger

Lawyers once "read law" under the tutelage of an experienced lawyer, and physicians took a few months' training in an M.D.'s office. Each then was considered "qualified" to go into practice without ever having attended law or medical school. Law and medicine are too complex and too important to society for such casual training anymore. So is environmental management. Consequently, environmental education has been revolutionized since 1970 to become, at all levels, *interdisciplinary/integrated/involved.* On-the-job training and clinical experience are necessary in environmental management. But such experience must follow and supplement, not substitute for, education in a community college, four-year college or university, and–usually, for maximum advancement–postgraduate studies.

THE COMMUNITY COLLEGE

In recent years a new institution, the community or junior college, has proliferated, and there are more than 1200 throughout

the United States. Wherever you live, there is certainly one nearby. For the local resident costs are modest, since it is usually supported by the county or city, and evening and weekend classes frequently are offered. You can take many liberal arts courses such as composition, mathematics, political science, music, art, philosophy, psychology, and many other liberal arts subjects. You can learn to use the library, the computer center, and other modern facilities. Usually, you can get acquainted with such new technologies as electronics and computer sciences. Most important to many students, you can acquire enough vocational skills to get a good job.

Abreast of the wave of environmental interest in the early 1970s, many community colleges developed special environmental curricula. The American Association of Community and Junior Colleges lists, among its member institutions, almost sixty associate-degree occupational programs in environmental education. The association also estimates that one or more of those courses are taught in more than 600, or one-half, of all two-year colleges. Most of the rest have applicable introductory survey courses, and all offer physical science courses which would quality you for a technical job related to environmental management.

THE FOUR-YEAR COLLEGE OR UNIVERSITY

Of the approximately 1800 four-year colleges and universities in the United States, the author estimates that at least half—nine hundred or more—offer comprehensive environmental studies. Most of the rest have applicable introductory survey courses, and all offer basic science, social studies, and mathematics courses adequate for a beginning job related to the environment.

Any selection from such a rich lode is necessarily arbitrary and incomplete. So, those mentioned here are "the author's choice."

It is likewise arbitrary, but perhaps useful, to categorize institutions into three types:

1. The new environmental colleges.
2. Liberal arts colleges with innovative programs.
3. Major university environmental programs.

THE NEW ENVIRONMENTAL COLLEGES

Most of the dozen or so new environmental colleges established in the late 1960s or early 1970s in response to rising environmental interest are thriving. Some started "from scratch." Others were established as units within existing liberal arts colleges. The new environmental colleges offer unique opportunities for satisfaction, inspiration, idealism, pragmatism, enjoyment, and involvement in real-life problems. Many of the professors are themselves products of the new environmentalism, and generally they are dedicated more to teaching than to research (the opposite would be the case in a major university). Students, by and large, have a deep and sincere interest in environmental affairs. Both faculty and students want to change the status quo; they are enthusiastic, excited, and "rarin' to go!"

Does that also describe you? If so, you might consider one of the new environmental colleges. Send for the catalogs of several. Most publications of these colleges are works of graphic beauty. Then visit the campus; there's nothing like experiencing the feel of a place, meeting the faculty and students, and sizing up all aspects of a place at which you are considering spending four years of your young life. Here is a selection of new environmental colleges:

College of the Atlantic is a small (only two hundred students), private, co-educational institution located on Mount Desert Island at Bar Harbor, ME 04609. COA (as it is abbreviated) dates from 1972. It offers four programs: social and environmental design and planning, human perspectives, education and communication,

and environmental sciences. Thirty-six credits are required for graduation, plus an essay in human ecology, a one-term workshop stressing problem-solving, laboratory or field work, internship for up to one year, and completion of a final project. All programs lead to the Bachelor of Arts in Human Ecology from COA.

Clear across the United States, **Huxley College of Environmental Studies** is one of three cluster units of Western Washington University at Bellingham, WA 98225. COA and Huxley have an exchange arrangement whereby students at one college may spend time at the other, for interchangeable credits. Huxley was named for Thomas Henry Huxley, the father of the eminent British family of scientists and writers. It is primarily an upper division institution; transfers with good academic records are welcome for junior year standing. Concentrations (majors) include human ecology, marine resources, marine planning, education, administration, systems and simulations, analysis, health, and monitoring. From 56 to 80 credit hours are required for the bachelor of science or bachelor of arts degrees.

The **State University of New York College of Environmental Science and Forestry** at Syracuse, NY 13210 has many unique qualities: it is strictly upper division/graduate. It is part of the State University of New York (SUNY) system. Although it adjoins, and is closely affiliated with, private Syracuse University, it is not formally part of that university. Nevertheless, each graduate of CESF receives, along with the SUNY diploma, one from Syracuse University, too. CESF has seven tracts totaling 27,000 acres, giving it the largest "campus" in the world. It is comprised of Schools of Biology, Chemistry and Ecology; Environmental and Forest Engineering; Environmental and Resource Management; and Landscape Architecture. In addition, there is a School of Forest Technology, which offers only an associate degree. All the other components offer bachelor's and master's degrees, and several offer the Ph.D. The college, chartered in 1911 as a school of forestry, was rechartered in 1972, to become one of the leading "new" environmental colleges–in this case, a full-fledged environmental university.

Students in resource management at the SUNY College of Environmental Science and Forestry at Syracuse spend several sessions in the field, putting theory into practice.

Formerly a teachers' college, the **University of Wisconsin-Green Bay** opened in its present form in 1969 at Green Bay, WI 54305. Millions of dollars were spent on new buildings for the scenic 600-acre campus on the shores of Green Bay itself. It achieved national recognition in 1971 when the editor of *Harper's Magazine* praised it as "Survival U.," and wrote that, if he "were about to start college, it would be my first choice—ahead of anything in the Ivy League." Founding Chancellor Edward W. Weidner calls it a *communiversity*, which he defines as "a socially responsible university relating to a socially responsible community."

As a student there, you would construct your academic program around a problem area having to do with some aspect of the environment. It might be pollution abatement. It might be a social problem such as family deterioration in the slums. Or it might be an economic problem such as cost-benefit analysis of toxic chemicals. While Green Bay advises the student seeking purely technical training to go elsewhere, it welcomes the person with broad interests, explaining in its catalog:

> With rare exceptions, it is a mistake for a young person starting college to feel that he or she must make a definite and permanent decision about vocational plans. There are still too many exciting career possibilities the young person has never considered, or of which he or she is only dimly aware. Furthermore, during a life-time career, fields will open that are not now apparent to anyone. Experience shows that many educated persons today engage in several different careers in the course of their lives.

In addition to the four colleges described, the "big league" of new environmental colleges includes: **The Evergreen State College**, Olympia, WA 98505; **Governors State University**, Park Forest South, IL 60466 (upper level only, largely for commuters from the Chicago area); **Hampshire College**, Amherst, MA 01002; **William James College**, a cluster college of Grand Valley State Colleges, Allendale, MI 49401; **New College** of the University of

Internships and field work for undergraduates at the University of Wisconsin-Green Bay are available all over the country, but no place for study of the biology of yellow perch fingerlings surpasses the shores of Green Bay itself.

South Florida, Sarasota, FL 33580; **Prescott College Center**, Prescott, AZ 86301; **Simon's Rock Early College**, a division of Bard College and located at Great Barrington, MA 02230 (the nation's only four-year college expressly for students who normally enter after the tenth or eleventh grade of high school, usually at ages sixteen or seventeen); **Unity College**, Unity, ME 04988; and **World College West**, San Rafael, CA 94902.

INNOVATIVE LIBERAL ARTS COLLEGES

The liberal arts college generally is constituted of a community of scholars devoted to teaching (not research and consulting); largely dedicated students; and, often, a rural or small-town atmosphere free of the distractions of the city. Virtually every such college has arrangements with several universities whereby you can transfer at, say, the end of the junior year to a university school of forestry or engineering. Then, after completing one year in the professional school, you would receive a bachelor's degree from the first college; and, ultimately, the professional degree from the university.

There are an estimated 300 liberal arts colleges with environmental studies concentrations or majors, among them these examples:

Allegheny College is a small (1800 students), private, coeducational institution at Meadville, PA 16335, sixty miles north of Pittsburgh. When Allegheny established its aquatic environments major in 1971, the intent was to prepare students for jobs immediately upon graduation. It was soon discovered, however, that most students were aiming for graduate work, so the emphasis was changed although some with the B.S. degree do find work. In response to student interest, a second program evolved at Allegheny. Called environmental resource management, it emphasizes social science and is for those preparing specifically for graduate work in landscape planning, environmental law, public resource administration, and the like. Later, so many students

expressed interest in journalism and communications that Allegheny inaugurated a third program in environmental advocacy. The director of Environmental Studies also is developing, within the liberal arts/distribution part of the curriculum, a suite of courses focusing on food production and resource management.

Middlebury College at Middlebury, VT 05753 is a small (under 2000 students), co-ed liberal arts college. It offers an interdisciplinary major in environmental studies with special preparation for careers in terrestrial or marine ecology, oceanography, earth science, physiography, human ecology, environmental engineering, environmental physics, and pollution control. The majority of graduates go on to graduate school. Nearby are superlative facilities for field work on Lake Champlain, in wilderness areas of the Green Mountains, and at a college-owned field station.

Northland College, Ashland, WI 54806, is a very small (700 students), co-educational institution with a well-rounded environmental studies program inaugurated in 1972. The major must take the core courses required of all majors. Also required are eight units with a biophysical emphasis, including two courses in chemistry and mathematics through calculus I, a level which qualifies the graduate for teacher certification. Each student must take a minimum of four electives, such as biology, geography, or physics. Also required are seven units with sociopolitical emphasis, from art through sociology. Many graduates find employment, with the bachelor's degree, as teachers in public and private outdoor education and recreation management, in food quality control, the paper and chemicals industries and utilities. Nearby Lake Superior provides a great natural laboratory for many environmental projects.

MAJOR UNIVERSITY ENVIRONMENTAL PROGRAMS

Disciplinary environmental studies originated with the establishment of the land-grant colleges and universities in the mid-nineteenth century. Frequently called "agricultural and mechanical" colleges, they offered agriculture, animal husbandry,

engineering, home economics, nutrition, and other applied arts and sciences. They generally came later than two other types of state institutions, teachers' colleges and state universities. The latter emphasized at their establishment, and still do, liberal arts plus such professional schools as law, medicine, and business administration.

What is new since the early 1970s is that a wide variety of all three types of state colleges and universities, as well as private institutions of higher education, offer a wide range of *interdisciplinary* environmental studies.

Not surprisingly, **The University of California at Santa Barbara** (CA 93106) made a direct response to the challenge of the disastrous oilspill there in January 1969. Writes a UCSB professor:

> The campus was within sight and smell of the littered channel and its beaches. Reaction was rapid. Within weeks 21 broadly representative faculty formed an adhoc committee to attack the twin problems of disciplinary "reductionism" and the "mind pollution" that lie at the root of environmental problems. By the fall of 1970 an environmental studies program was in being at UCSB.

That program is characterized as liberal arts education for the generalist. It gives the student "a holistic view of the environment," in the professor's words. One "star" of the faculty is Roderick Nash, distinguished environmental historian.

Indiana University at Bloomington, IN 47401 (and five other campuses) offers environmental studies in both the College of Arts and Sciences and the School of Public and Environmental Affairs. The span of degrees reaches from the scientific and technical aspects of environmental science to their political and social applications. The distinguished faculty has backgrounds in biology, economics, geography, geology, political science, public and environmental afffairs, zoology, and many other areas. A "star" is Lynton K. Caldwell, who first suggested the environmental impact statement idea which characterizes the National Environmental Policy Act.

The Department of Man-Environment Studies was created at the **University of Waterloo**, Ontario, Canada N2L 3G1, in 1969 as a four-year undergraduate program leading to an honors Bachelor of Environmental Studies degree. The curriculum requires completion of twenty-two full (two-semester) courses or the equivalent. Each student must complete an environmentally oriented project each year. Energy is a basic theme of study in the first year. The student explores the generation and consumption patterns for different sources of energy, their implications for air and water pollution, the question of development of the North (of Canada), protection of the rights of native Northerners (Canadian Indians and Eskimos), and the high-consumption lifestyles of industrialized countries.

IS THE ENVIRONMENTAL STUDIES DEGREE MARKETABLE?

The liberal arts program is frequently called a "useless education." Admittedly, its graduates sometimes have difficulty getting jobs. Is environmental studies a "fad curriculum," destined to produce a surplus of unemployables? The author thinks not. He is, rather, optimistic about the potential of an environmental studies curriculum which is truly *interdisciplinary/integrated/involved*, for these reasons:

- An environmental studies bachelor's degree, like any other liberal arts degree, is suitable for the student who is aiming for graduate work in an environmental science.
- An environmental studies bachelor's degree also is an acceptable foundation for postgraduate studies which may not be directly related to the environment.
- An environmental studies bachelor's degree qualifies one for entry to some fields for which the bachelor's is standard for professional practice, e.g., agricultural sciences, fisheries, soils or wildlife conservation, range management or indus-

trial hygiene, plus some of the categorical specialties in environmental health.

- Finally, there are new fields of employment—an example is preparing environmental impact studies and reports—where the environmental studies graduate may be better qualified than someone with a narrow science or engineering specialty. Employers increasingly are recognizing this advantage and are hiring generalists including those from environmental studies.

SPECIAL OPPORTUNITIES FOR THE MINORITY STUDENT

As a new field, environmental studies and managment is leading the way in offering equal opportunity to women and to minorities. Women and people of all races and backgrounds hold mid-level and top positions in government and industry. What is newly recognized, however, is that the educational system lags in providing, for college admission, qualified persons from under privileged backgrounds. For one thing, minority students frequently have too little contact with the role models in environmental professions. For another, they may have inadequate guidance into the kinds of courses which are essential preparation for environmental careers.

These inequities are now being addressed, for the first time, in a significant new project of the Human Environment Center in Washington, D.C. In a report the center describes the problem:

> College and professional school programs leading to careers in environmental or resource management require students to have strong scientific preparation and good study skills. All too many minority students are receiving inadequate English, math or science training. . . . [This is] widely recognized by educators as a crucial reason for the small numbers of minority college students in scientific disciplines.
>
> High school teachers generally concur that students headed for science or engineering must be in a college-

bound curriculum starting with algebra by eighth or ninth grade. Fifth grade is cited by others as the signal year when students must be "on track."[1]

WHERE SHOULD YOU WRITE FOR MORE INFORMATION?

American Association of Community and Junior Colleges
1 Dupont Cir., NW
Washington, D.C. 20036

Conservation Education Association
c/o Wilson F. Clark
CEA Services Coordinator
Eastern Montana College
Billings, MT 59101

ERIC Clearinghouse for Science, Mathematics, and Environmental Education
The Ohio State University
School of Natural Resources
1200 Chambers Rd. (3rd floor)
Columbus, OH 43212

Human Environment Center
1302 18th St., NW
Washington, D.C. 20036

National Association for Environmental Education
Brukner Nature Center
5995 Horseshoe Bend Rd.
Troy, OH 45373

[1] "Before College. Report 1, Minority Education for Environmental and Natural Resource Professions." Washington, D.C.: Human Environment Center, 1980, p. 17. (The Center identifies as minorities the following: Blacks, Mexican Americans, mainland Puerto Ricans, and Native Americans.)

Overleaf: Eugene P. Odum, distinguished ecologist of the University of Georgia, is never too busy to take graduate students out in the field to demonstrate methods of studying ecosystems.

CHAPTER 3

THE SCIENCES OF LIVING THINGS

> Although "ecology" is frequently misused as a synonym for "environment," popularization of the subject is having the beneficial effect of focusing attention on man as a part of, rather than apart from, his natural surroundings.[1] – Eugene P. Odum.

PROFESSIONS COVERED

Ecology, Biology, Environmental Chemistry

When Eugene P. Odum arrived at the University of Georgia as a young instructor in biology, he suggested that a course in ecology be included in the core curriculum for majors. His suggestion, he writes, "received an exceedingly cold reception."[2] Naturally, he was disappointed. In part as a result of that rebuff, in 1940 he decided to write a textbook emphasizing unique principles of ecology. The first edition of *Fundamentals of Ecology* was published thirteen years later, and it has become the most acclaimed textbook in the field.

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[1] Eugene P. Odum, "The Emergence of Ecology as a New Integrative Discipline," *Science*, Vol. 195, No. 4284. 25 March 1977, p. 1290. Copyright 1977 by the American Association for the Advancement of Science. Reprinted by permission of the AAAS and the author.

[2] *Ibid.*, p. 1289.

ECOLOGY

In a pyramid of definitions, the *biological sciences* (or *biosciences*) would be the base or most basic *life science* term for the *interdisciplinary/integrated/involved* area we are considering here. In the box next above would be *biology*, and in the box at the top, *ecology*. In this chapter we shall try to explain simply, as Odum might have to his fellow faculty at the University of Georgia many years ago. Odum's definition is:

> Literally, ecology is the study of organisms "at home." Usually ecology is defined as the study of the relation of organisms or groups of organisms to their environment, or the science of the interrelations between living organisms and their environment. Because ecology is concerned especially with the biology of *groups* of organisms and with *functional* processes on the lands, in the oceans, and in fresh waters, it is more in keeping with the modern emphasis to define ecology as the study of the structure and function of nature, it being understood that mankind is a part of nature.[3]

As the public's awareness of environmental issues began to emerge in 1968, "some professional ecologists actually resented the public's use of 'their' word," Odum reports.[4] He himself welcomed the popularization of ecology as a long overdue recognition of holistic ("wholeness") concepts.

Dr. Odum has spent virtually all of his career at the University of Georgia, Athens, GA 30601, where he is Callaway Distinguished Professor of Ecology and director of the Institute of Ecology. Over the years he has received many honors, some of them, incidentally, with his brother, Dr. Howard T. Odum. Dr. Howard

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[3] Eugene P. Odum, *Fundamentals of Ecology*, Third Edition, p. 3. Copyright 1971 by W. B. Saunders Company. Copyright 1953 and 1959 W. B. Saunders Company. Reprinted by permission of Holt, Rinehart and Winston and the author.

[4] *Science, op. cit.* p. 1290.

Odum also is a prominent environmental scientist (with special credentials in energy), at the University of Florida, Gainesville, FL 32601.

THE WORK OF ECOLOGISTS

What do ecologists do? Almost invariably, ecologists are engaged in interdisciplinary research on one or more phases of four components of *ecosystems*, or ecological systems. These components are: individual *organisms; communities*, (meaning groups of organisms); *populations*, including species distribution and how the organisms of various species interact; and ecological *subsystems*. An ecologist's approach to the study of an ecosystem is described in the words of the careers folder of the Ecological Society of America:

> The mathematically-oriented can choose systems analysis, setting up mathematical models of the life systems of particular species of plants or animals and, with the aid of computers, learning how to predict or control population numbers of desirable or undesirable organisms under a detemined set of conditions.

Ecology usually would be considered a *basic* (meaning, to many, perhaps, an "impractical") science, but its principles underlie every other discipline in environmental management. Such related fields as wildlife and fisheries conservation, forestry, and other areas of natural resources management depend upon the ecologist's measurement and interpretation of the relationships and support systems of the organisms, collections of organisms, communities, and ecosystems.

WHAT EDUCATION WOULD YOU NEED TO BE AN ECOLOGIST?

Not even the ecologist could be expected to have all the knowledge of every other scientist. What the ecologist may have that the others do not have is the unique approach of looking for relation-

ships. If you feel that you have that turn of mind, that intellectual curiosity, and the capacity for thinking deeply and caring greatly about your work, you might consider a career in ecology.

The Ecological Society of America, in its careers folder, stresses the importance of early preparation in high school. Take a well-rounded program including biology, mathematics, physics, geology, chemistry, social sciences and humanities. In college, you might major in the biological sciences, taking courses in morphology, physiology, and genetics, as well as ecology. Inorganic and organic chemistry are essential, and biochemistry and physical chemistry may be important for certain areas of ecology. If you aspire to a research career—and most ecologists do—you should take as much physics and mathematics as possible, including calculus, linear algebra, probability theory, statistics, computer science, and economics. French and German are recommended as the languages of choice, with Russian and Chinese growing in popularity.

In your high school or college years, you should be able to find summer jobs related to ecology, and thereby judge whether you have sufficient interest and aptitude to specialize in this field. Specialization can begin during undergraduate years, with a major in biology, botany, or zoology, with special preparation in general ecology. But a B.S. degree is not sufficient; you should expect to go on for a master's and eventually a doctor's degree. Most professional ecologists hold the Ph.D.

WHERE WOULD YOU WORK AS AN ECOLOGIST?

Teacher, researcher, or administrator—the ecologist most often fills all three roles simultaneously. Some do research exclusively, as employees of the federal or state government, frequently at an agricultural experiment station of a land grant college. Still others work for private companies in forestry, paper products, or large agricultural operations. Moreover, ecologists study the impacts of energy developments on the environment. Oil and natural gas

producers have ecologists on their exploration teams, along with geologists and other earth scientists. Such teams are studying the outer continental shelf, coastal zone, estuaries, and even desert areas to establish baseline conditions before new facilities disrupt the ecology, to monitor the environment while new facilities are being built, and to assure that problems do not arise after these facilities are in operation. Any industry or utility that is planning to build, for example, a power plant in a fragile environment needs to employ an ecologist for such studies. (Dr. Ruth Patrick, a distinguished ecologist, of the Academy of Sciences in Philadelphia, is a frequent consultant to Du Pont on such matters.)

Most basic research in ecology is sponsored by the National Science Foundation through grants to universities. Other government agencies, primarily the Departments of Agriculture, Interior, and Defense; the Environmental Protection Agency; and the National Oceanic and Atmospheric Administration are major employing agencies. The United Nations Environment Program, various specialized U.N. agencies, and private philanthropic foundations employ ecologists in international programs.

WHAT IS THE JOB FUTURE FOR ECOLOGISTS?

Ecology is an extremely small field, one of the smallest among the professions discussed here. The Bureau of Labor Statistics does not even describe it in its *Occupational Outlook Handbook*, nor list a D.O.T. (*Dictionary of Occupational Titles*) number for "ecologist" in the index to the handbook.* There is no licensing or registration to provide official figures. Based on his own informal surveys, the author estimates that there are approximately

*Less excusably, the Department of Labor's Employment and Training Administration and the Environmental Protection Agency, in their joint *Environmental Protection Careers Guidebook*, do not include ecology among the 106 occupations covered. The guidebook, nevertheless, is recommended. See Appendix A.

7500 professional ecologists, up from 5000 a decade earlier, in the United States and Canada. We can be optimistic. Compound growth over the next decade, though slightly slower than before, should provide a net gain of 2500 new ecologists, for a total of 10,000, by the mid-1990s.

BIOLOGY

The biologist's first commitment is to the traditions of science; the second is to the particular profession of *biology*; and the third to the subdivision of biology in which one practices. At least those are the priorities suggested by the American Institute of Biological Sciences (AIBS), which defines its field:

> Biology, the most intriguing and pervasive of sciences, is the study of life and living things. It is actually a multi-science composed of many disciplines unified by the fact that all living things—plants, animals, and microorganisms—follow the same fundamental laws of heredity, reproduction, growth, development, self-maintenance and response.

Most scientists probably find their particular professions "the most intriguing and pervasive of all sciences" (or they would have chosen some other discipline). Nevertheless, the thrust of the definition is factual. Most scientists are intellectually curious and honest. They are continually posing hypotheses and testing them against observations. When satisfied with the validity of resulting data, they are eager to publish, to share the information with their peers in a scientific journal, so that others may replicate the experiments, validate the results, and contribute substantiating evidence and additional data. Of such shared progress is all science advanced.

A story will illustrate the consequences of one microbiologist's quest. In the early 1970s, Ananda M. Chakrabarty, a microbiologist who was born in India and later came to work at the General Electric Company's research laboratories in Schenectady, NY,

discovered that the genes responsible for certain bacteria's ability to break up hydrocarbons are not contained, as previously expected, in the bacterium's single chromosome, or principal repository of *DNA*, the genetic molecule. Rather, the genes reside elsewhere in the cell, in something called *plasmids*. Taking plasmids from three oil-eating bacteria, this scientist transplanted them into a fourth, thereby creating a cross-bred version which literally "eats" oil. Thus was created a quick and ecologically safe way to help consume oil spills in harbors, rivers, and the oceans. What oil is left is dispersed widely so it will be harmless to living things.

A decade later, the U.S. Supreme Court ruled that the discovery was patentable. Meanwhile, other scientists had been working in the related area called *recombinant DNA*, gene manipulation, or gene splicing. The techniques thus developed meant that scientists were ready to create new life forms in the laboratory through "genetic engineering." In little more than a decade, several new industries have begun to emerge from this fundamental research on the frontiers of knowledge. In addition to oil-eating bacteria, recombinant DNA technology offers unlimited, and as yet unimagined potential. Some scientists already are working on producing synthetic insulin, which would be a boon to those who suffer from diabetes. Others are working on an antiviral protein called *interferon*, that could be effective against several types of cancer.

The Indian-born scientist who launched the industry built on patentable forms of life is a *microbiologist*, a biological scientist (or bioscientist) who investigates the growth and characteristics of microscopic organisms such as bacteria, viruses, and molds. Although such a scientist might or might not be considered an environmental scientist, the consequences of the science have widespread environmental applications and implications. The biologist who studies plants is a *botanist*; and the one who studies animals a *zoologist*. Another, who studies form and structure, including development, is a *developmental biologist*. Yet another who studies the function of whole organisms and their components is a *physiologist*. The one concerned with the hereditary

mechanisms which control both structure and function is a *geneticist*. He or she who studies the evolution and classification of plants and animals is a *systematist* or *taxonomist*. Refer back to the definition of *ecologist*, and you will note that any of these biologists might also be considered an ecologist. To some extent, it depends on what one considers oneself: "I am better versed in ecology than in other types of biology, therefore I am an ecologist!"

In the late 1940s, soon after World War II ended, new techniques of systems analysis and new technology such as digital computers became available. They enabled ecologists to approach problems more complex than ever before, such as those in molecular science and resource management, where millions of bits of data are needed to characterize interrelations. In the 1980s, the most exciting frontiers in all of science are those which merge the new biology and the even newer bio-engineering techniques.

Awesome possibilities are opened. Says the National Science Foundation's top advisor on recombinant DNA:

> Theoretically, any process occurring in nature can be harnessed for man's use. We could even learn how to duplicate photosynthesis, the basic energy-converting process in green plants!

WHAT EDUCATION WOULD YOU NEED TO BE A BIOLOGIST?

To become a biologist you should have as much high school science and mathematics as possible, preferably four years of each. You should have a bachelor's degree. Virtually every college and university provides training in biology to the B.S. or B.A. level. An environmental studies curriculum, such as described in Chapter 2, would include much biology. Professional jobs in biological research are difficult for the bachelor's graduate to find. You can maximize your employability, however, by taking lots of English,

chemistry, physics, and mathematics, as well as statistics and computer sciences.

When you are ready and able to begin postgraduate studies, by all means do so. Graduate school need not follow immediately upon receipt of the bachelor's degree. Many students are neither psychologically ready nor financially able to go on to graduate school right after college. Take the best available job, even though it may be beneath the level for which you are qualified. It will afford useful experience, provide income to meet later graduate school expenses, and give you a "breather," a change of pace, even a chance to move to a new city or a new part of the country.

Alternate periods of work and study are often the student's best course. Such a plan lets you put theory into practice; provides practical experience essential to advancement; helps make choices on career goals and objectives and allows perspective on personal as well as professional decisions. Those are the reasons that cooperative education, for example, has been so successful at many schools of engineering, and why many of the colleges and universities mentioned in Chapter 2 require internships of all undergraduates.

With only a bachelor's degree, you would have limited possibilities for advancement in research and development or other professional tracks. New graduates at this level often get testing and inspecting jobs or become technical sales and service representatives. With courses in education, you might become a secondary school biology teacher. A master's degree is essential for a senior position in industry or a college faculty appointment.

Many employers, public and private, provide such incentives to graduate study as time off with pay, tuition and fees, and sometimes living and other expenses. At least, an employer satisfied with an employee's work may hold open the job while he or she is away for further learning.

Membership in professional societies is optional, and there are no licenses or registrations required for the biologist. As in other sciences, one's peers exert pressure to publish research

findings and to participate in professional activities. Even so, this pressure would be felt largely by the biologist on the college or university faculty, not on the one in industry or government.

WHERE WOULD YOU WORK AS A BIOLOGIST?

The largest fraction of biologists is engaged in teaching and research at colleges and universities. The next largest works in private industry, especially in pharmaceuticals, chemicals, and food processing. The third largest segment is government employed, notably in the Departments of Agriculture and Interior, the National Institutes of Health, and the armed services. Finally, a few thousand work for nonprofit research organizations.

Biologists are distributed fairly evenly throughout the United States because higher education and industry are so widely dispersed. But employment is concentrated in metropolitan centers or on college campuses.

THE PARAPROFESSIONAL IN THE BIOLOGICAL SCIENCES

Many of the 6000 vocational schools and all of the 1200 community colleges offer curricula which prepare the graduate for a job in science and technology. Training is given in skills needed to monitor, inspect and analyze specimens; to collect and interpret data; and to conduct field programs requiring contact with the public. Someone with some post-high school education, but only a high school degree, is considered to be an *aide*, a noun which usually is modified by an adjective, for example, a *biological aide*. The graduate of a two-year program in a community college, with an Associate in Science (A.S.) or Associate in Arts (A.A.) degree, is generally considered a *technician*, the higher level of paraprofessionalism. Many universities offer similar degrees upon the completion of a two-year curriculum.

WHAT IS THE JOB FUTURE FOR BIOLOGISTS?

The Bureau of Labor Statistics expects employment in the life sciences to increase faster than the average for all occupations over the next decade. Among the reasons it cites for this prediction, in the *Occupational Outlook Handbook*, are:

> . . . increased attention to preserving the natural environment and a continuing interest in medical research. . . . Employment opportunities in industry and government should grow as environmental research development increase and new laws and standards protecting the environment are enacted.

For the truly creative senior researcher in the life sciences, the creation of new life forms in the laboratory through DNA research holds incredible prospects for achievement and honors at the Nobel Prize level. For most Ph.D. biologists, a career in research and teaching promises a good living and the deep satisfaction of knowing that one is contributing to advances in medicine, environmental sciences, and industrial applications.

How many biologists are employed in environmental management, and what numbers can we put on the foreseeable growth in demand? Taking the Bureau of Labor Statistics' estimates of 215,000 persons working in the life sciences, of which BLS says that 110,000 are biologists, it is possible to hypothesize that 100,000 (about half of the larger number) probably are in environmental biology. That would be an increase from 75,000 in the mid-1970s. (None of these estimates includes people employed in ecology, environmental health or agricultural sciences; those environmentalists are counted elsewhere in these pages.)

The author estimates, conservatively, that the number will reach 125,000 by the mid-1990s. Since one aide or technician is commonly required to support each professional in a research field like biology, it is a reasonable assumption that 100,000 paraprofessionals are employed in environmental biology now, and 125,000 will be required by the mid-1990s.

ENVIRONMENTAL CHEMISTRY

Chemistry is the science of the composition, structure, properties, and reactions of matter, including its atomic and molecular systems.

Chemistry often is considered an environmental science in its own right, and the American Chemical Society publishes the journal *Environmental Science & Technology*. An environmental emphasis may enter into any of the major subfields of chemistry, as well.

The analytical chemist determines the structure, composition, and nature of substances and develops new techniques. Originally, the *organic chemist* studied the chemistry of living things, but this area has been broadened to include all carbon compounds. When combined with other elements, carbon forms an incredible variety of substances. Many modern commercial products, including plastics and other synthetics, have resulted from work in organic chemistry. The *inorganic chemist* studies compounds other than carbon and may develop, for example, materials for use in solid state electronic components. The *physical chemist* studies energy transformations to find new and better energy sources. The *toxicologist* conducts tests on animals to determine the effects of drugs, gases, poisons, pesticides, radiation and other substances on the health of the organism. The *biochemist* or *biophysicist* studies the chemical and physical behavior of living things. Since life is based on complex chemical combinations and reactions, the work of the biochemist is vital for an understanding of the basic functions of living things such as reproduction and growth. The biochemist also may investigate the effects of substances such as food, hormones or drugs on various organisms.

The *chemical engineer* is involved in many phases of research on chemicals and byproducts and their production. This is not normally thought of as an environmental specialty, but when the work is the design, testing and operation of chemical processes such as those to remove chemical contaminants from waste materials, it clearly is environmental in nature and in applications.

WHAT EDUCATION WOULD YOU NEED TO BE AN ENVIRONMENTAL CHEMIST?

Nearly every college and university offers a basic degree in chemistry. Only selected engineering colleges offer a chemical engineering degree. More than 350 institutions offer graduate degrees in chemistry. Graduate students generally are required to have a bachelor's degree in chemistry, biology, or biochemistry. Many graduate schools emphasize some specialties of chemistry over others because of the type of environmental science research being done at those institutions. If you lean toward a certain type of environmental career, you should pick your graduate school with that leaning in mind. Graduate training requires actual research in addition to advanced science courses. For the doctoral degree, you specialize in one field of chemistry by doing intensive research and by writing a thesis.

Can you work either independently or as a member of a team? A chemist should be flexible enough to switch from one mode to the other frequently. Do you have analytical ability and curiosity? Do you have patience and perseverance, as well as a low level of frustration and fatigue? You will need all of those qualities to complete the hundreds of experiments frequently necessary to solve a single problem. Often, you must repeat certain steps again and again, keeping careful records of data.

WHERE WOULD YOU WORK AS AN ENVIRONMENTAL CHEMIST?

Colleges and universities employ 15 percent of all chemists and about 50 percent of all biochemists. The rest are scattered throughout governmental agencies and industry including, of course, chemical manufacturing. They also are fairly evenly distributed throughout the United States and Canada, especially in metropolitan areas, on college campuses, and at agricultural and other research stations.

Become a chemist, biochemist, or chemical engineer, and there is no limit as to where you might find employment—no limit as to organization, geography, or type of function, including medicine, agriculture, and sales and management.

The environmental chemist, like many another scientist, might have to roam the world, as does Dr. Maurice Shamma of the Pennsylvania State University, University Park, PA 16802. He has collected plants in India, Burma, Thailand, and Sri Lanka. And what experiences a plant hunter has! In the last-named country, formerly called Ceylon, he and a local botanist spent days of fruitless search for a certain plant species. After they had given up, Shamma spotted a lone tree in the yard of a house as they were driving past. "That's it!" he shouted, braking the jeep to a halt. After negotiating with the householder, he drove away leaving an astonished but richer family puzzled at the strange ways of an American who would pay generously for half of their source of shade!

WHAT IS THE JOB FUTURE FOR ENVIRONMENTAL CHEMISTS?

The *Occupational Outlook Handbook* says, in selections from several write-ups:

> Employment opportunities in chemistry are expected to be good for graduates at all degree levels. . . The anticipated growth in this field (biochemistry) should result from the effort to find cures for cancer, heart disease, and other diseases, and from public concern with environmental protection. Colleges and universities may need additional teachers of chemistry as enrollments continue to increase. . . . The Toxic Substances Control Act is creating many new openings for toxicologists and other life scientists who are skilled in testing for cancer-causing substances.

Dr. Maurice Shamma hopes that these bales of plants he collected in Pakistan will yield valuable medicinal drugs. Photo: Charles Fergus, The Pennsylvania State University.

In addition to public health and environmental protection, part of the impetus for such employment can be expected from growth in the chemical industry. It makes more than $120 billion worth of products each year and its growth rate is twice that of the United States' economy as a whole. Another part of the impetus surely will come from our growing energy demands.

How many chemists are employed in environmental management, and what numbers can be put on the foreseeable growth in demand? Let's begin with the BLS's estimate: 140,000 chemists, 20,000 biochemists, and 50,000 chemical engineers. We assume half of the chemists and biochemists to be in environmental sciences work—a total of 70,000 and 10,000 respectively: up from 60,000 and 8,000 respectively in the mid-1970s. (Only 10 percent of the chemical engineers can be assumed to be in the

environmental sciences: 5,000 today, up from 4,000 in the mid-1970s.) We foresee modest growth of chemists, to 80,000; stronger growth of chemical engineers, to 8,000; and modest growth of biochemists, to 20,000; for a grand total of 108,000 professional practitioners in environmental chemistry by the mid-1990s, plus an equal number of paraprofessionals.

A COMMENT ABOUT COMPENSATION

Inflation is driving salaries up so rapidly that any statement published is quickly outdated. Salaries also are rising because of cost-of-living increases, civil service escalation, collective bargaining, and so forth.

For current information, contact any of the professional societies listed at the end of this and following chapters. The current *Occupational Outlook Handbook* (revised every other year, available in most libraries and listed in Appendix A) gives salary ranges for hundreds of job categories.

WHERE SHOULD YOU WRITE FOR MORE INFORMATION?

American Association for the Advancement of Science
1515 Mass. Ave., NW
Washington, DC 20005

American Chemical Society
1155 16th St., NW
Washington, DC 20036

American Institute of Biological Sciences
1401 Wilson Blvd.
Arlington, VA 22209

American Institute of Chemical Engineers
345 E. 47th St.
New York, NY 10017

American Society
for Microbiology
1913 Eye St., NW
Washington, DC 20006

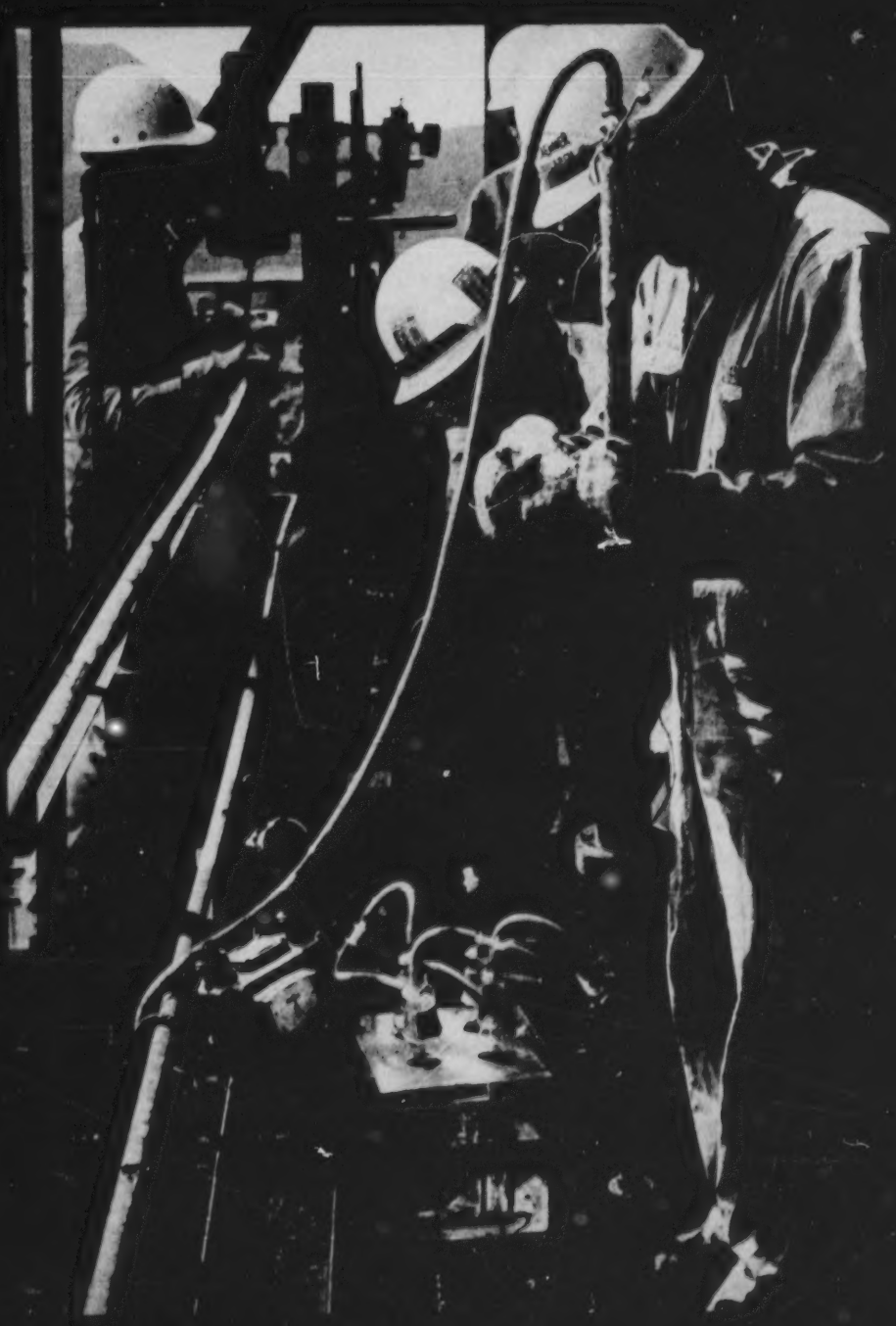
American Society
of Biological Chemists
9650 Rockville Pike
Bethesda, MD 20014

American Society of Zoologists
Box 2739
California Lutheran College
Thousand Oaks, CA 91360

Ecological Society of America
c/o Dr. Paul G. Risser
Department of Botany
and Microbiology
University of Oklahoma
Norman, OK 73019

Scientific Manpower
Commission
1776 Mass. Ave., NW
Washington, DC 20036

Overleaf: Using a portable sampling train, environmental engineers of Bethlehem Steel Corporation's Homer Research Laboratories, Bethlehem, PA, and the environmental control department of the Sparrows Point, MD plant analyze the operation of an air pollution scrubbing system.



CHAPTER 4

ENVIRONMENTAL HEALTH

Man is a part of nature and the benefits are real. He has only to conserve plant and animal life, and the resources of the earth, to share in nature's bounty and beauty. But man can also suffer because of his close relationship with nature: Many diseases pass from animals, insects, and soil to humans. The beautiful blue heron, like the golden-haired child with diphtheria, can be the source of disease.–*Tracking Diseases from Nature to Man* (Centers for Disease Control)

PROFESSIONS COVERED

Environmental Engineering
Environmental Health Sciences
Environmental Medicine
(Including Environmental Nursing and Public Health Veterinary Medicine)
Environmental Sanitation
Health Physics
Industrial Hygiene
Categorical Specialties

In 1900 communicable diseases were responsible for half a million deaths in the United States. Gradually the poor health

conditions of Americans improved due to various factors, among them general sanitation, pure drinking water, improved food and nutrition and environmental and industrial improvements.

By 1949 several communicable diseases, including cholera, dengue, epidemic typhus and yellow fever, had virtually disappeared from the United States. Today, many of the dangerous communicable diseases are rare, and people are living longer and healthier lives than ever before. Yet, there are emerging new and critical health problems, many of which are associated with environmental conditions.

HOW DO WE FEEL ABOUT OUR HEALTH?

The period around Earth Day, 1970, brought a massive change in attitudes, values, and collective efforts to confront the problems of *environmental health* in the United States. When the Environmental Protection Agency (EPA) was established in that year, it was given the major responsibility for conducting or coordinating most of the on-going environmental protection and pollution control programs of the federal government. These programs had grown piecemeal over the years and were scattered among many agencies. Soon the Congress passed new laws, backed them with unprecedented billions of dollars in appropriations of public funds, and created in EPA new environmental protection programs in superabundance.

Almost everyone concedes the value of air and water pollution in reducing disease. In a report to the Council on Environmental Quality (CEQ), a professor of economics at Bowdoin College made the following judgments:[1]

[1] A. Myrick Freeman III, "The Benefits of Air and Water Pollution Control: A Review and Synthesis of Recent Estimates," 1980. Washington, DC: Council on Environmental Quality.

- Between 1970, when the Clean Air Act was passed, and 1978, the resulting improvement in air quality is believed to have saved at least 14,000 American lives.
- The annual benefits of air pollution control are estimated to be at least $21 billion—some say they could be as high as $51 billion!
- Looking ahead, the control of conventional water pollutants—such as phosphorus, bacteria from human waste, and dissolved oxygen—should result in annual benefits averaging $12 billion.

The CEQ concedes that such estimates are anything but precise, but it calls them conservative. They do not include, for example, benefits accruing to other countries such as Canada and Mexico because of air pollution control in the United States.

What about the many unseen, poorly-understood and unexpected problems? The National Cancer Institute reports that the rate of cancer incidence in the United States is rising for the first time in twenty-five years. With the exception of smoking, causes of the rise have not been determined. Some epidemiologists (experts in the spread of disease) attribute much of the increase to chemical carcinogens (cancer-causers) in the workplace and the environment. As expected, the chemical industry strongly disputes this. Research into possible connections between environmental factors and cancer incidence have recently been intensified.

How do people come into contact with chemicals that may cause cancer, birth defects and mental retardation, as well as many lesser curses? They may be exposed to them in the workplace, in food, water and cosmetics. Chemicals which are poisonous are called toxic substances.

We can come into contact with toxic substances almost everywhere in the environment. Decades ago, people began dumping chemicals any place they could find—"out of sight, out of mind." The Environmental Defense Fund has studied 214 such sites and estimates that as many as 1.2 million persons are exposed to serious health hazards from them. But, according to the Fund, there

could be as many as 50,000 such forgotten, dangerous dump sites across the nation!

You may have seen television documentaries on these dumps. The most newsworthy case is Love Canal in Niagara Falls, NY, a community of homes that were actually built on a former chemical grave site. When dangerous poisons began oozing from the surface, hundreds of households were evacuated, and the President declared Love Canal an emergency area—the first time in history that emergency status had been conferred in the case of a human-caused disaster.

Nobody knows whether or not an increase in cancer incidence may have been caused by the 1979 accident to the nuclear reactor at Three Mile Island, PA, but a principal recommendation of the Presidential Commission that investigated it was to strengthen the inspection and health physics program of the Nuclear Regulatory Commission.

Finally, acid rain is another newly recognized and critical environmental problem. When sulfur and nitrogen oxides emitted from factories and automobiles mix with the moisture in the atmosphere, they form acids. These acids can be transported through the atmosphere hundreds, even thousands, of miles to places that may or may not have any factories or automobiles. When American industry shifts, because of fuel energy costs or supply, to burning more coal, the sulfur dioxide emissions are increased, adding to the atmospheric burden. The resulting acidity in the atmosphere travels without respect for state or national boundaries, and it falls to earth in acid rain, affecting not only human health but also small green plants, forests, land animals, fish, and buildings. Air pollution from Illinois and Ohio, traveling eastward, causes acid rain damage in New York State. Consequently, the fabled fishing lakes of the Adirondack Mountains no longer offer trout to the fishers. The Lincoln Memorial in Washington, DC is deteriorating at many times the expected rate because of acid rain. So is the Parthenon of Athens, Greece, which has withstood the weather for centuries. Finally, acid rain causes an in-

crease in heavy metals in our water supplies, with consequences to human health not yet fully understood. The United States and Canada have established a joint study committee to investigate the acid rain problem.

Which of the above problems is directly connected to energy? Certainly the automobile with its contribution to air pollution is. And all forms of nuclear radiation from power reactors are. In fact, almost all of the problems mentioned have some connection with energy. And as the nation accelerates the synthetic fuels program (*synfuels* is the headline tag for the production of gasoline from coal and oil from shale), environmental challenges of enormous scope and complexity must be faced by environmental professionals of almost all disciplines.

PROFESSIONALISM

There are several marks—especially important in environmental health; less important in the categories which follow—whereby one becomes, and is identified as, a *professional*. The most common is *membership in a professional association*, a privilege usually accorded anyone who graduates from an accredited college or university with a degree in the discipline. The principal professional organizations listed at the end of this and other chapters are examples. These associations provide services such as professional education and information to their members. They provide career information to students and general information and services to the media and to the public. They represent the profession in dealing with other professional organizations, with regulatory and licensing bodies, and in lobbying in Washington and state capitals.

Certification is the process by which a nongovernmental agency or association (such as a professional organization just mentioned) grants recognition to an individual who has met certain predetermined qualifications.

Registration is the process by which qualified individuals are listed on an official roster maintained by a governmental or non-governmental agency. Within some professions there are specialty boards or registries established by the professions themselves. These boards identify those members of the profession who meet certain requirements of education, experience and competence, as demonstrated by passing an examination. Such individuals may be accorded the title of "Fellow" or "Diplomate."

Licensure is the process by which an agency of government grants permission to persons meeting predetermined qualifications to engage in a given occupation which directly affects the health and welfare of the public, and sometimes permits these persons to use a particular title. More than thirty occupations in the health field are licensed in one or more states. All fifty states and the District of Columbia require licensure of civil engineers, environmental health engineers, and others when they are engaged in engineering work which may affect life, health, or property—and who offer their services to the public on a fee basis. The initials P.E. after a person's name stand for Professional Engineer, a mark of professional distinction. All fifty-one jurisdictions also require licensure for physicians (Medical Doctor, M.D., and Doctor of Osteopathy, D.O.), and several dozen other professions or trades.

What about *unionism*? Scientists and engineers traditionally have thought of themselves as professionals, "white collar" workers, "above" labor unions, which were for "blue collar" workers. But the distinctions are becoming more blurred all the time. Unlike most physicians and lawyers in professional, fee-for-service, private practice, most scientists and engineers work for employers for salaries. There is an employer-employee relationship, with the potential for collective bargaining. Not surprisingly, American Federation of Labor-Congress of Industrial Organizations (AFL-CIO) affiliates recently have succeeded in invading the ranks of government at all levels, as well as universities, hospitals, and other places where professionals traditionally have shunned

unions. It is now becoming quite common for scientists, engineers, physicians, nurses, teachers, and others to join unions. And it is always a professional's right to do so.

ENVIRONMENTAL ENGINEERING

As an *environmental engineer*, you would command the specialized engineering knowledge essential to solve environmental problems which are engineering in nature. Because so many environmental problems are *interdisciplinary/integrated/involved*, increasingly the engineer is *the* key member of the management team.

Engineering is defined as the means by which the properties of matter and the sources of energy in nature are applied to practical purposes. The first engineers in America were combinations of civil and military. For example, George Washington is regarded as the father of the engineering profession as well as the father of his country. Civil engineers laid out plans for cities and designed and supervised the construction of roads, harbors, tunnels, bridges, etc. Then, as now, civil engineers with additional specialized training in sanitation and called *sanitary engineers* were responsible for designing and building safe public water supplies and wastewater treatment facilities and controlling flying/crawling vectors of disease such as flies and mosquitoes. By controlling the mosquitoes which carry malaria and yellow fever, the sanitary engineer made possible the building of the Panama Canal where the French had failed because of those diseases' toll. The sanitary engineer designed the sanitation facilities which have made our cities the world's healthiest.

While sanitation is still a part of the job, the practice of sanitary engineering today is much broader than sanitation. To reflect the broader responsibilities, this practitioner is generally called an *environmental engineer*.

Everything this engineer does, which used to be so simple, now is complex. For example, for more than a century chlorination has been the simple and inexpensive treatment which has made the water safe to drink. Now, chlorination is known to be inadequate to remove the toxic chemicals mentioned as so prevalent in our water supplies. And it is suspected of actually *causing* cancer in some who drink the water! Sewage—or waste water, as it is usually called today—treatment also presents a challenging problem of new magnitude for the environmental engineer. Water pollution control laws prohibit the discharge of inadequately treated sewage into navigable rivers and bays. At the same time, cities are running out of land for the disposal of sewage sludge. Before sludge can be used more widely as a fertilizer, new methods of removing toxic chemicals and metals must be developed.

The search for both new domestic supplies of energy and new methods of energy conservation and efficient use confronts the environmental engineer with myriad new problems. They are described by the Department of Energy (with emphasis added) in its recruitment booklet:

> The generation and use of power can seriously affect the environment (and consequently people) through gaseous emissions, despoiling through mining, the release of heat, the disposal of radioactive wastes, oil spills, and the like. *The use and misuse of energy is probably the greatest single threat to the environment. The environmental engineer thus has his or her work cut out.*

The energy industry is a major employer of environmental engineers. They assess the potential environmental impact of a new power plant, oil refinery, offshore oil rig, or electrical transmission line or oil or gas pipeline, before it is built, monitor it while it is being built, and assure that it always operates correctly and safely. They use an array of monitoring instruments and techniques to detect trouble before it arises and to avert it.

The environmental engineer is responsible, too, for providing engineering leadership or support to programs of hazardous wastes control, noise abatement, public safety and resource conservation, toxic substances control, regional planning and land use, and literally hundreds of others. Even in the inner cities, environmental engineers are adding to their traditional roles of sanitation and insect and rat control such new initiatives as programs to prevent traffic accidents, mitigate lead poisoning from paint and from auto emissions, rehabilitate housing and provide community amenities.

WHAT EDUCATION WOULD YOU NEED TO BE AN ENVIRONMENTAL ENGINEER?

Over 200 engineering colleges offer a B.S. degree in environmental engineering. Some have converted their old sanitary engineering curricula. Others have merged that with industrial hygiene, safety engineering, and other disciplines. Still others have created new programs in engineering management, environmental studies or general engineering, any of them broad enough to incorporate the science and engineering subjects needed by an environmental engineer.

If you aspire to rise to a senior professional position, you must plan to take a master's degree in environmental engineering. A second master's in business or public health administration would be helpful. If you expect to go into research or university teaching, a Ph.D. is mandatory.

An engineering college may be more demanding about prerequisites, grades and class standing than a liberal arts college. Even so, you would spend much of the first two years in engineering honing up on subjects you may already have taken in high school: mathematics, physics, biology, and chemistry, plus humanities, social sciences, and English. In the second two years of college you would be introduced to engineering subjects, especially

chemical, design, electrical, electronic, industrial, mechanical, mining, and oceanographic engineering. You also would get your first taste of environmental administration and law, and repeated instruction in and exposure to computer sciences. Many liberal arts colleges have arrangements with university engineering schools whereby a student can spend three years at the college and two years at the university and receive a bachelor's degree from each institution. Other engineering colleges have cooperative, "co-op," programs—five- or six-year plans under which one alternates between school and employment.

WHERE WOULD YOU WORK AS AN ENVIRONMENTAL ENGINEER?

The traditional employers of environmental engineers, according to the Association of Environmental Engineering Professors, have been local government units such as city or county health departments, state governments, and federal agencies. The Bureau of Labor Statistics does not describe this field in its *Occupational Outlook Handbook*, nor is there any other source of accurate statistics. In the author's observations, however, the areas in which employment is rising most rapidly are consulting engineering firms and manufacturing and energy industries. The former employ environmental engineers for research and studies on contract, to prepare and evaluate environmental impact statements, and to assure compliance of their client companies with the myriad governmental laws and regulations to which they are subject. Manufacturers from every major sector—aircraft, aluminum, electrical equipment, industrial chemicals, logging and lumber, motor vehicles, nuclear energy, paper, petroleum refining, and textiles, just to name a few—employ environmental engineers. So do companies in coal mining and petroleum and natural gas production, processing, and distribution by pipeline, ship, or truck; transportation—aviation, railroads, and trucking; public utilities—electric

power, cable television, telephones, microwave towers, etc.; and real estate and land development companies.

Interested in adventure overseas? Increasingly, consulting engineering and construction firms with contracts with the oil-producing nations of the Middle East advertise for environmental engineers, among others. They are building, in addition to oil and natural gas facilities, whole new cities, industrial complexes, ports, university campuses, highways, airports–in fact, entire new "developed" nations are springing up on the desert. Consequently, they need significant numbers of environmental engineers. The armed services also offer some of the more attractive opportunities for environmental engineering practice.

WHAT IS THE JOB FUTURE FOR ENVIRONMENTAL ENGINEERS?

In the mid-1970s there were about 10,000 environmental engineers. The author's studies indicate that the field has doubled to about 20,000 now in practice, and that 50 percent more will be needed to fill the 30,000 jobs which should be available by the mid-1990s. Probably no more than one-third of these would require licensure as Professional Engineers. Probably no more than 5 percent, mostly professors and researchers, would pass the additional examination necessary to be certified as a Diplomate of the American Academy of Environmental Engineering.

ENVIRONMENTAL HEALTH SCIENCES

This is a little-known category, the science counterpart to the environmental engineer. It is characterized by the *interdisciplinary/integrated/involved* approach taken to the job. Its practitioner may have been educated in the life sciences, the physical sciences or the social and behavioral sciences. He or she may have one or more degrees in ecology, biology, or chemistry. The graduate

school education may be in agronomy, anatomy, animal science, bacteriology, biochemistry, botany, embryology, microbiology, pathology, pharmacology, physiology, zoology—the list could go on and on. The important distinction from the disciplinary scientist is that in the course of such a person's career, a new turn has been taken. It has been a turn towards the new environmentalism.

As an *environmental health scientist*, you would hold a key position on a team concerned with environmental protection or public health. You would be in command of the specialized knowledge, often scientific, connected with environmental problems. You would be aware of, and sensitive to, the concerns of others. You would assume command of the team when its assignments were largely scientific. Frequently you would: (a) search for, detect, and analyze environmental pollutants; (b) characterize and study the biological effects of pollutants (or of things such as noise which cause stress, and are called "stressors"); (c) determine their epidemiological character (meaning the distribution geographically or through populations, as an epidemic disease might spread); and (d) devise criteria and standards for abating the pollutants, or otherwise solving the environmental health problem.

Because this is such a broad category, and its practitioners frequently add management degrees to their scientific skills, you will find many environmental health scientists occupying middle level or top administrative positions in which they run programs and supervise others.

WHAT EDUCATION WOULD YOU NEED TO BE AN ENVIRONMENTAL HEALTH SCIENTIST?

A bachelor's degree in biology, chemistry, or general science from literally any college or university would be an appropriate foundation for this field. If your institution offers an environmental studies major, that too might be suitable if it was heavy in emphasis on science. Along the way, you should take as much management, statistics, and computer sciences as possible. You

Almost forty chemical companies, acknowledging the lack of data about the toxicity of the nearly 50,000 compounds they produce, in the mid-1970s established the Chemical Industry Institute of Toxicology at Research Triangle Park, NC 27709.

should aim, as soon as possible, for graduate school and get a master's degree. In declining order of preference, some would say, would be a master's in public health administration, public administration, business administration, management or one of the environmental sciences. Many persons prefer to round off their educations with a second master's degree in a scientific discipline. But if you can afford it and have the necessary stamina and ambition, by all means go for a Ph.D. in any of those fields. If you have a chance to pick up a law degree along the way, it would be helpful in qualifying you for an administrative or public policy job.

WHERE WOULD YOU WORK AS AN ENVIRONMENTAL HEALTH SCIENTIST?

Local, state, and federal government agencies employ the majority of environmental health scientists, in departments such as public health, environmental protection, conservation, and fish and wildlife services. Most young persons probably don't think first of the military, but the armed forces offer some of the more attractive career opportunities in environmental health. Colleges and universities employ environmental health scientists to teach and do research, as do the major non-profit research institutes. Industry employs a growing number in environmental management departments and at research laboratories. In addition to managing research programs, they may be responsible for keeping up with the flow of paper needed to comply with the tremendous number of government regulations regarding health and safety.

WHAT IS THE JOB FUTURE FOR ENVIRONMENTAL HEALTH SCIENTISTS?

This is another job area which the Bureau of Labor Statistics does not describe in its *Occupational Outlook Handbook*. In this author's studies, we estimate that there were 20,000 envi-

ronmental health scientists employed in the mid-1970s, that there are 28,000 today, and that 34,000 will be needed by the mid-1990s. (Re-read the earlier section "What Is the Job Future for Environmental Chemists?" Most of the statements and assumptions there would apply to environmental health scientists as well.)

ENVIRONMENTAL MEDICINE

By definition, those licensed in one or another type of medicine are the only professionals qualified, certified, and permitted to examine and treat patients. (Here's a little test: What kind of patients popped into your mind when you read the preceding sentence: Children? Adults? Yourself? If you automatically thought of sick *persons*, you anthropomorphized–jumped to the conclusion that *patients* means *people*. Of course, it may, but read on.)

The category of *environmental medicine* consists of four different professionals, whose functions are in some ways similar to those of environmental health scientists, but differ in one respect: they are the only professionals who can treat patients. The degrees, with the abbreviations which distinguish them, are:

Doctor of Medicine (M.D.)
Doctor of Osteopathy (D.O.)
Registered Nurse (R.N.)
Doctor of Veterinary Medicine (D.V.M.)

(Now is it clear that one treats, not people, but other animals?)

Any one of the four professionals listed could be in charge of a particular environmental health team for disease control, laboratory research, or field studies; which one would be in charge would depend upon which individual was senior, and which had the expertise to deal with the problems confronted.

Because the two types of physicians are similar, we can consider them together:

THE ENVIRONMENTAL PHYSICIAN

Any physician is responsible for diagnosis, treatment, and prevention of disease, injury or other physical or mental condition of the human patient. Both M.D.s and D.O.s use all accepted methods of treatment. Osteopathic physicians (or osteopaths), however, believe particularly but not exclusively that the proper functioning of the musculoskeletal (muscle-bone) structure of the body is integral to the maintenance of the individual's overall health. So, although they may prescribe (and perform) surgery, diet or medicine, as necessary, the key to their therapy is manual adjustment of the offending structure–say, the spine. Osteopaths were long regarded by medical doctors (especially as represented by the American Medical Association) as "unequal," and their therapy and education were regarded as "inferior." Only very recently have they become accepted, through professional upgrading of their schools and postgraduate training (as well as through lobbying and legal pressure), and through changing mores (added to public resentment against the American Medical Association as a "closed guild"). Acceptance is complete today, insofar as federal and state laws can compel it: in the armed forces, in the Public Health Service, and in state and local health departments. Some local medical societies accept osteopaths, and some general hospitals accept them, but both types of institutions have a great deal of autonomy and can set their own requirements.

Many physicians emerge from the long course of education and training–eight to ten years or more beyond high school, the longest regimen of any profession–challenged by the opportunity not just to *treat* disease, but to *prevent* it. They may have been idealistic to begin with. Something then may have happened to push them in the direction of preventive medicine and public health. It could have been exposure to a charismatic professor, experience in working with the poor in a slum clinic, a stint in the uniformed services, overseas internship, or an assignment in the Peace Corps or the Indian Health Service of the Public Health

Service. Preventive medicine and public health (environmental health) is one of twenty-two specialty areas from which the M.D. may choose; there are sixteen specialties available to the D.O.

WHAT EDUCATION WOULD YOU NEED TO BE AN ENVIRONMENTAL PHYSICIAN?

Basic education—four years of college and four years of medical school—is required of all physicians, regardless of later specialization. Specialty training may take an additional two to five years or more.

The high school student aiming for pre-med and med school takes about what any science major would take—math, science, English, speech, and social studies. In college, one continues with advanced courses in all those subjects, plus physics, basic calculus, biology, organic and inorganic chemistry, and one or two languages.

Medicine is *the* most difficult profession to enter. It enjoys the highest prestige and the highest level of remuneration of almost any calling, so it attracts the brightest students with outstanding secondary school records. Competition for limited slots in freshman classes is extremely keen. If you aim for a career in medicine, aim high and aim early. At about the junior year in college, you must take a medical college preadmissions test. (See your counselor about arrangements to take it, as well as about meeting the other qualifications for admission to medical school.)

There are 126 "regular," and nine osteopathic, medical schools and colleges in the United States. The federal government operates only one, the Uniformed Services University of the Health Sciences, Bethesda, MD 20014.

A physician's degree training takes four years. In some schools with accelerated programs, i.e., no summer vacations it can be completed in three. One takes anatomy, pharmacology, biochemistry, physiology, microbiology, and pathology, plus clinical

subjects such as pediatrics, radiology, obstetrics-gynecology, and internal medicine. Laboratory and clinical training are increasingly integrated throughout the four years.

All states require a license to practice medicine. The state licensing board gives its examination annually, it is taken by those M.D.s who have had one year of residency (in the case of D.O.s, it is called "internship.") Additional specialty training may be required. To conduct research or to administer programs, a license is not required, but most researchers and administrators with healing arts degrees choose to be licensed.

A physician must "go to school" throughout life. Most of this learning is informal, as in any profession, but much of it is formal, too. Many specialties require that a training course of about 150 hours be taken at least every three years. Certification by a specialty board is a mark of distinction for any medical specialist.

Environmental medicine is particularly rich in the resources available for lifelong learning. This specialist may choose, usually after a few years of practice, to attend a school of public health for the Master of Public Health (M.P.H.) or Doctor of Public Health (D.P.H.) degree. The purpose of this additional education might be primarily to acquire new scientific skills. It might be primarily to become qualified to teach public health methodology. Or it might be to learn to manage a complex program (something medical school does not teach). Of course, it might be all three things together.

WHERE WOULD YOU WORK AS AN ENVIRONMENTAL PHYSICIAN?

The physician you probably are most familiar with is in private practice, self-employed and working alone, sharing an office or in group practice with other physicians. The environmental physician is different in being employed by a unit of government—local, state or federal.

The only environmental physician you normally would come into contact with is the epidemiologist of your local public health department, or you may also have heard of the renowned "disease detectives" of the Centers for Disease Control in Atlanta, GA 30333. These investigators keep their bags packed, ready to fly on a moment's notice, anywhere in the nation—or anywhere in the world—to study disease outbreaks associated with the physical environment. CDC is probably one of the three largest centers of environmental medicine research, training, and field services. The others are the National Institute of Environmental Health Sciences, one of the National Institutes of Health, and the Environmental Research Center of the Environmental Protection Agency; both are at Research Triangle Park, NC 27709. These three organizations also may be the largest employers of environmental physicians.

One can meet military commitments by service at any of those federal agencies (or other uniformed services' hospitals and labortories). The military services and the Veterans Administration also are major employers of environmental specialists of many kinds, including physicians, and they have some of the largest and best research facilities in environmental medicine.

If you were not federally employed, you might be on the faculty of a school of medicine or of public health. Or you might work for a private corporation in its medical department, health and safety department, occupational medicine services, or research laboratory. Pharmaceutical companies employ environmentalists of all kinds, medical specialists included, in their research laboratories and in field investigations.

If you are interested in adventure overseas, the opportunities are unlimited. Consulting engineering and construction firms employ environmental physicians. So do federal agencies such as the Agency for International Development (AID). Private organizations such as the Rockefeller Foundation, New York, NY 10036 employ environmental physicians, as does the World Health Organization, headquartered at Geneva, Switzerland.

Some environmental physicians conduct part-time practices or serve as part-time consultants or lecturers–teachers at schools of medicine or public health. Many retire to lucrative jobs in industrial medicine, pharmaceutical research or testing, clinical medicine, product development, toxicology, teaching, or other private-sector endeavors. Others expand, or take up, private practice, either in the places where they have worked or in Sun Belt retirement areas.

WHAT IS THE JOB FUTURE FOR ENVIRONMENTAL PHYSICIANS?

Environmental medicine is comparatively small, one of the smallest of the fields discussed here. Based on his own informal surveys, the author estimates that there are approximately 6,000 environmental physicians in the country today, up from about 4,000 in the mid-1970s. Compound growth should be by arithmethic progression, for a total of 8,000 by the mid-1990s.

THE ENVIRONMENTAL NURSE

The nurse traditionally has been an important member of the public health team, serving in hospitals and clinics, in research laboratories, and out in the community, tracking and treating disease alongside the physician. He or she also long has been concerned with all the steps–immunizations, examinations, and inspections of the home and community–necessary to *prevent* the spread of communicable and infectious disease. A good bit of the credit for taking the vaccines, medicines, and education to people wherever they lived goes to the public health nurse. Today, this nurse, who might be called an *environmental nurse*, is a full member of the *interdisciplinary/integrated/involved* environmental health team. He or she is as important now as the "nurse on horseback" was in the backwoods three-quarters of a century ago.

A new vaccine which offers potential protection from influenza is administered by a CDC nurse epidemiologist to a volunteer in a vaccine efficacy study. It is given first to a large sample of elderly persons because of the high risk the disease presents to the elderly. Photo: The Centers for Disease Control, Public Health Service.

WHAT EDUCATION WOULD YOU NEED TO BE AN ENVIRONMENTAL NURSE?

There are about 1,400 nursing programs available in the United States. In addition, over one hundred universities offer master's degrees and several offer doctorates. Anyone interested in public health–the basic field of which environmental nursing is a part–should enroll in a bachelor's degree program (as opposed to the majority of programs which have lower requirements). Public health agencies require a B.S. or B.A., and prefer a master's as well. All states require a licence to practice.

The high school student aiming for a degree in nursing should take, through high school and college, the same type of curriculum described above for the environmental physician. Similar resources for lifelong learning are available to the nurse as well as to the physician.

WHERE WOULD YOU WORK AS AN ENVIRONMENTAL NURSE?

All of the statements made above for environmental physicians apply, as well, to environmental nurses.

WHAT IS THE JOB FUTURE FOR ENVIRONMENTAL NURSES?

In the mid-1970s there were about 7,000 environmental nurses, only a small fraction of the more than one million registered nurses in the United States, but up from 4,000 in the mid-1970s. The Bureau of Labor Statistics expects growth in employment of registered nurses to be faster than the average for all occupations, because of the extension of prepayment programs for hospitalization and medical care. It also would be due, in part, to increased public and political interest in preventive medicine, environmental health and rehabilitation of the handicapped. The author's studies indicate that 10,000 environmental nurses will be needed by the mid-1990s.

THE PUBLIC HEALTH VETERINARIAN

If you live in the city or suburbs, you probably are familiar with the veterinarian who gives inoculations to dogs and cats and

treats them when they get sick. If you live in the country, you probably know the "vet" as a doctor who makes "house calls"—or "barn calls," for sick horses and cows. But, in either case, you may not know that there are "zoonoses," diseases which can travel under a variety of natural conditions between vertebrate animals and people. (Pronounced *zoo-o-no-sees*, accented on the third syllable.) Anthrax, for example, may be transmitted through the skin when one comes into contact with contaminated hair, wool, hides, and manufactured products containing those substances. Certain types of food poisoning may be acquired by eating products containing frozen or dried eggs contaminated with salmonella. Q fever is an airborne infection frequently suffered by veterinarians, dairy workers, and farmers. Psittacosis is called "parrot fever," and it strikes those who work around birds. In all, there are more than forty such diseases to which humans are prone and in the transmission of which animals play some role. They also include several forms of encephalitis, which mosquitoes can transmit between humans and horses; Rocky Mountain spotted fever, transmitted by ticks, of which rabbits, field mice, and dogs are hosts; and trichinosis, whose infectious agent resides in swine, many wild animals, and marine mammals, and which is transmitted to humans through infected meat, chiefly pork and pork products.

A veterinarian with a rural practice sees more communicable disease than the city counterpart. In addition to working with animal patients, such a vet must educate the animals' owners about the zoonoses. Ringworm is not uncommon in cows, horses, and domestic household pets and could infect children. The farmer could acquire brucellosis from the air in the cattle barn or by drinking contaminated milk. A tick hidden in a child's hair could bring paralysis and death.

But the environmentalist with whom we are concerned here is the *public health veterinarian*, a highly regarded professional and an essential member of the *interdisciplinary/integrated/involved* environmental health team.

WHAT EDUCATION WOULD YOU NEED TO BE A PUBLIC HEALTH VETERINARIAN?

Considering a career as a veterinarian in public health practice? Then take about what any other intended science major would take in high school: math, science, English, speech, humanities, and social studies. Some colleges of veterinary medicine will admit you on only two or three years of undergraduate college work and without a bachelor's degree. Some require four years and the degree. Other entrance requirements also vary widely, so it is best to investigate several veterinary medical schools and then aim for one or two. Almost all require (as do medical colleges) inorganic and organic chemistry, biochemistry, zoology, botany, physics, English composition, and speech.

The United States and Canada have about two dozen accredited schools or colleges of veterinary medicine, which offer a four-year professional program leading to the Doctor of Veterinary Medicine (D.V.M.) degree. If your state university includes such a school, you will receive preference for admission over an out-of-state student. States which do not have veterinary schools usually have contracts with states that do and subsidize their residents' educations in those schools.

Understand, however, that the competition for limited spaces in veterinary schools' freshman classes is extremely keen. The profession has benefited from the environmental movement in several ways. Being a veterinarian appeals to young environmentalists because it involves animals and is close to nature. It contributes directly to agriculture and food production, including the chance for Americans to extend some of those blessings to less fortunate peoples in other lands. Finally, at the beginning of the 1970s, some who failed to gain admittance to regular medical school settled for veterinary medical school, instead. As a result of those and other factors, it is now about equally as hard to gain admittance to veterinary school as it is to regular medical school.

Much of the pre-clinical curriculum is the same in both types of medical education and includes anatomy, physiology, pathology, pharmacology, and microbiology. The second phase of veterinary education is largely clinical.

A license is required to practice veterinary medicine in all states. Unlike the M.D. or D.O., the D.V.M. does not have to have an internship or residency, though these are becoming more common. To conduct research or to administer programs, a veterinarian does not have to be licensed, but as in the case of other practitioners, many public service veterinarians choose to be licensed.

The public health veterinarian also may choose, usually after a few years of practice, to attend a school of public health for the Master of Public Health (M.P.H.) or Doctor of Public Health (D.P.H.) degree. Thus, one can add to a unique veterinary medicine background, new skills in science and medicine, public health methodology, and program administration and management.

WHERE WOULD YOU WORK AS A PUBLIC HEALTH VETERINARIAN?

Three out of four veterinarians are in private practice, many of them owning and operating the small-animal (meaning dogs and cats, mostly) hospitals seen in every suburb and along the highway near every city. The public health veterinarian is different in being employed by a unit of government, local, state, or federal.*

Public health veterinarians practice in the widest variety of settings of any environmental professionals. The following listing does not exhaust the possibilities.

When a "zoonosis" is even remotely possible, veterinary epidemiologists on the staff of, or in training at, the Centers for

*Some vets in private practice, especially in rural areas, may also work part-time for an agency of government.)

Disease Control are among the disease detectives who investigate disease outbreaks.

A veterinarian can meet military requirements or make an interesting career serving in the veterinary corps of the Army or Air Force. One's functions in such service would usually relate to protection of the health of military personnel against the zoonoses described above. But they also could be general sanitation, research or a hundred other functions indistinguishable from the general-science duties which might be performed by a Ph.D. or M.D. A veterinarian also can meet military requirements by service in the commissioned corps of the Public Health Service, most commonly at the Centers for Disease Control, described above, or assigned to a state or local health department.

Then there are some functions essential to public health protection which only the veterinarian is qualified or permitted by law to perform. You have noticed in the grocery ads, "Grade A Prime" or "Choice" meats advertised. A federal veterinarian certified that meat after inspecting it in the packing plant and labeled it to protect you against disease. Other veterinarians of the Department of Agriculture supervise the health of animals in stockyards, inspect poultry, enforce quarantine regulations, and monitor the export and import of animals and animal products. They assure the safety and quality of drugs used to treat animals, both to protect the human consumers of meat against communicable diseases and to protect the investment which farmers and others have in the animals' health. And they conduct research on, (and supervise the licensing of firms which manufacture), serums and vaccines for animals. Interestingly, veterinarians also have a responsibility under federal law to monitor and assure that livestock are slaughtered as humanely and painlessly as possible.

Veterinarians in the Science and Education Administration of the U.S. Department of Agriculture participate in a wide range of research activities: to improve livestock (and poultry) productivity through improved breeding, feeding, and management practices and to develop methods for controlling animal diseases, and para-

sites and insect pests which affect livestock. In addition to basic and applied animal research, these scientists have new priorities such as research to develop energy technologies to reduce animal agriculture's dependence on fossil fuels. Veterinarians, among others, are confronted by such questions as: Can solar-heated barns provide adequate housing for animals, and can the manure from various animal operations produce enough methane gas to supply nearby buildings with heat and electricity?

Much research of that type is conducted in federal laboratories and in cooperative experiment stations of the state colleges and universities. It also is conducted by other university staffs under federal contracts and grants. Hundreds of veterinarians, federal and otherwise, participate in these studies. Veterinarians also are employed by the U.S. Food and Drug Administration to help protect consumers by assuring the safety and purity of drugs used to treat animals.

Almost all of the statements made above about opportunities for environmental physicians also apply to opportunities for public health veterinarians. Pharmaceutical and chemical companies employ them in research and testing. Private foundations engaged in medical, public health, food, and wildlife preservation activities around the world employ veterinarians for environmental programs.

WHAT IS THE JOB FUTURE FOR PUBLIC HEALTH VETERINARIANS?

Statistics are incomplete, and we must make more assumptions regarding the numbers of public health veterinarians in *environmental* health than are made regarding the numbers of environmental physicians and environmental nurses. That is because *all* physician-epidemiologists and nurse-epidemiologists for example, are clearly in environmental medicine. But not all public health veterinarians are in environmental work. The distinction is largely one to be made by the individual and is

determined by how one regards one's professional activities. Any veterinarian engaged in epidemiological studies would be an environmentalist, but one engaged in drug research might or might not be.

The author's studies identify 2,000 veterinarians in environmental medicine in the mid-1970s, estimate that there are 3,000 today, and project 4,000 by the mid-1990s.

THE NEXT HORIZON: AN AUTHOR'S NOTE

You may remember that Chapter 2 was devoted to bachelor's level programs in *interdisciplinary/integrated/involved* environmental studies. There, we stressed that such a program usually did *not* qualify one for professional practice as ecologist, biologist, chemist, engineer, health scientist, physician, nurse or veterinarian. But we lauded such programs for their demonstrated success in preparing graduates at the B.A. or B.S. level to enter graduate school to become professionals in the fields named. For most of the named fields, at least a master's degree is needed, for several a doctorate is required, and for all of them an appropriate doctorate is recommended.

Now we come, in the pages ahead, to a series of professions for which bachelor's level studies are usually sufficient qualification for entering professional practice, providing the bachelor's degree is in the discipline or profession described. In some cases, a bachelor's in environmental studies from a liberal arts college or university, with a major in the discipline named, is all you need to qualify for most openings that might be available. Examples in Resources and Recreation are some types of conservationists, range managers, and recreation specialists; and in Land Use and Human Settlements, the planner. In virtually all of the fields the master's is the highest degree necessary, and the doctorate is sought only if one plans to teach and do research at the university level.

ENVIRONMENTAL SANITATION

If you are more interested in practical problems than in theory, better satisfied by helping people avoid trouble than in working at a laboratory bench, then consider becoming a *sanitarian*. But be prepared to get your hands dirty and your shoes muddy–and your ancestors cursed–for this is a job with nitty-gritty chores, and it is regulatory. A sanitarian enforces health and safety regulations, never the most popular assignment, and even subject to having an angry manager run after you with a meat cleaver in hand!

The sanitarian traditionally was responsible for interpreting and enforcing local, state, and federal laws, regulations, and standards–mostly local, it should be noted–respecting the sanitation of food, milk, water supply, garbage disposal, sewage disposal and housing. Today, to those responsibilities have been added others: obtaining community action for better health through better environmental sanitation of all types. This means that the sanitarian promotes and helps secure such improvements as water supply extension, improved sewage disposal facilities, safer recreational areas, and more hygienic conditions in nursing and convalescent homes.

One level of duty is that of inspector, checking on the cleanliness of dairies, food processing plants, restaurants, and plant and hospital food services. As a sanitarian you would also visit schools, hotels and motels, swimming pools, parks, and certain types of housing to observe, make measurements, collect samples and specimens for laboratory analysis, and make recommendations regarding the facilities' compliance with public health and environmental protection and safety laws and regulations. Another level of duty is as regulator, citing violators of codes or even closing them down.

A third level of duty for the senior sanitarian is as manager. You would then develop and manage programs to prevent contamination, control insects and rodents, manage disposal of wastes, and insure adequate water supplies. You might also plan for

emergency disaster aid; teach health education classes; speak before community groups; and work with the county agent on agricultural sanitation problems such as disposal of animal and vegetable wastes.

A supervising sanitarian plans and directs environmental health programs and may supervise a large staff. Sanitarians at all levels serve the public as educators and interpreters. They provide consultation to owners, operators, and employees of businesses; to contractors; to school, government, and elected officials; and to any citizens who wish to pose questions or requests. They may draft proposed laws and regulations. They may give expert testimony in court cases involving alleged violations of such laws and regulations. They may serve as arbitrators in quasi-judicial proceedings. With the recent emergence of new and more complex pollution problems, especially those involving toxic wastes and hazardous substances, the sanitarian can be expected to be called on far more frequently, by all the parties named, for expert advice and counsel.

Obviously, the job overlaps the duties of the biologist, chemist, engineer, and health scientists already described, as it does those of the categorical specialists and generalists discussed at the end of this chapter.

WHAT EDUCATION WOULD YOU NEED TO BE A SANITARIAN?

A bachelor's degree in biology, chemistry, general engineering or environmental sciences generally is acceptable for an entry job as sanitarian. In most states one cannot practice as a professional sanitarian without a bachelor's degree. Over sixty colleges and universities offer a bachelor's degree in environmental health (or sanitation), which requires a minimum of thirty semester hours in the physical or biological sciences. The communications and liberal arts courses mentioned so frequently in connection with other professions are stressed. A typical curriculum's core courses

would include microbiology (bacteriology), biostatistics, epidemiology, environmental sciences, administration, and field work.

Registration is required in thirty-five states. National certification is available through the National Environmental Health Association; upon passing an examination and meeting other requirements, one can add the designation R.S., Registered Sanitarian, after one's name.

A graduate degree is not offered in sanitation as such, but sanitarians frequently take graduate work, through the master's level, in science, public health, management, or some other field, and sometimes the doctorate.

Perhaps to a greater degree than in jobs which are more discipline-oriented, it is imperative that the sanitarian keep up-to-date with rapidly changing knowledge and technology, without forgetting the social and political events which shape the world. He or she must read the literature—and, it is to be hoped, contribute his or her own experiences and observations—about such matters as carcinogens in air and water; asbestos fibers in air, water, and dust; radiation and noise; and about new measuring instruments and equipment, as well as computers and their applications to the problems of environmental health.

WHERE WOULD YOU WORK AS A SANITARIAN?

Three out of four sanitarians work for the federal, state or local governments. Another group works for producers and processors of food and dairy products. Others teach, consult or work for hospitals, trade associations or for such firms as insurance companies. Because of their broad background in environmental sciences, such people move readily back and forth between the private and public sectors. With added educational and experience qualifications, they qualify for steady advancement and new challenges.

WHAT IS THE JOB FUTURE FOR SANITARIANS?

At the same time that the duties of the sanitarian have broadened, the number of businesses which must be inspected has expanded. Think of the rapid growth that you have observed of restaurants, shopping malls, and fast-food places.

In the mid-1970s there were about 20,000 sanitarians. As programs, particularly on the local level, have expanded, there has been rapid growth of numbers employed, to about 35,000. The author foresees only slight leveling, to approximately 45,000 professional sanitarians by the mid-1900s.

HEALTH PHYSICS

The *health physicist* (alternatively, *radiological physicist* or *radiobiologist*) is responsible for the health aspects of radiation. This is the professional who is concerned with the design, testing, maintenance, and operation of X-ray machines and related radiation equipment. This professional works with radioactive materials, nuclear reactors, and particle accelerators. He or she takes measurements of environmental radioactive backgrounds, natural or man-made. While the proliferation of nuclear power reactors has slowed because conservation has reduced the growth of demand for electricity, and fewer nuclear power reactors will become operational before the end of the century, public concern over accidents such as Three Mile Island has intensified job demand.

WHAT EDUCATION WOULD YOU NEED TO BE A HEALTH PHYSICIST?

A bachelor's degree in physics is sufficient to qualify one to an entry job as a health physicist. Courses in chemistry, biology, and

computer sciences are essential. A master's degree with emphasis on statistics would be helpful.

The American Board of Health Physics certifies professionals as C.H.P.s (certified health physicists) when they meet prerequisites and pass an examination. Approximately 1,000 have been certified.

WHERE WOULD YOU WORK AS A HEALTH PHYSICIST?

Since the accident at Three Mile Island and the investigation of it, the nation's nuclear health and safety program has been considerably augmented. The Nuclear Regulatory Commission, as a consequence, is a major employer of health physicists. Another is the U.S. Department of Energy, both on federal jobs and indirectly through the contractors who run the national laboratories such as Argonne, Brookhaven, Oak Ridge, Los Alamos, and Hanford. Another category of employer is hospitals and medical research institutions which use X-rays and radiation for therapy. Health physicists also are employed by state and local health and environmental protection departments. In the private sector, the manufacturers of radiation equipment, power companies, and consulting firms employ considerable numbers.

WHAT IS THE JOB FUTURE FOR HEALTH PHYSICISTS?

It appears that there were about 2,000 health physicists in the mid-1970s, and such trends as the proliferation of nuclear power reactors caused a short-lived boom. After energy conservation caused a slowing of demand for electricity, power companies cancelled many contracts for nuclear reactors and halted work on plants under construction. After Three Mile Island, the public

protests against nuclear power siting and the enormous burden of down-time costs—$1 million or more per day that a plant is not in operation!—even power enthusiasts took a second look at nuclear energy. All such factors are having inhibiting effects on nuclear programs.

More and more health physicsts are required to meet the health and safety regulations for those plants which remain in operation. Various electronic devices are coming into ever more widespread use, too: microwave ovens in homes and restaurants, elaborate CAT scanners (for rapid, accurate diagnosis of tumors) in hospitals, and a variety of radiation instruments in plants and laboratories. The health physics profession has doubled, to 4,000 practitioners today, and is expected to rise another 50 percent, to 6,000, by the mid-1990s.

To a considerable extent, today's employees—and tomorrow's—will owe their jobs to the consumer advocate Ralph Nader. His crusades for health and safety precautions in the workplace and the total environment led directly to many of the programs which employ health physicists.

INDUSTRIAL HYGIENE

A third professional, closely related to the sanitary engineer and the sanitarian, yet different, is the *industrial hygienist*. Become one, and, as the title indicates, you would work in or with industry. You would conduct activities to eliminate if possible, at least to control, occupational health hazards and diseases. Concerns include: (a) chemical stresses such as dust or gas; (b) physical stresses such as radiation or noise; (c) biological factors including insects and fungi; and (d) ergonomic (that is, work-related) stresses such as monotony and work pressure.

Many specialists are trying to anticipate the potential cancer, birth defects, mental retardation, emphysema, black lung disease,

and mental illnesses which might result in the years ahead from stresses in the workplace today. The industrial hygienist is the key professional who can take immediate, practical steps to tighten standards, remove hazards, and ban toxic substances whenever they are identified. These steps alleviate short-term illness and contribute to long-term worker health.

WHAT EDUCATION WOULD YOU NEED TO BE AN INDUSTRIAL HYGIENIST?

The basic educational requirement for industrial hygiene is a college degree with a major in engineering or one of the physical sciences. A few technological universities offer degrees, but most professionals are graduates of other institutions with a major or minor in the field. Graduate programs are available, and industrial hygienists frequently take a master's in science, business administration, industrial management, or public administration.

WHERE WOULD YOU WORK AS AN INDUSTRIAL HYGIENIST?

The industrial hygienist usually works in, and always works with, industry. This might be in the occupational health department of any manufacturing company or with an insurance company holding workers' compensation policies for a number of companies with multiple plants. Or it might be a transportation company such as an airline, a public utility, mining operation, labor union or a consulting company serving many clients. Increasingly, opportunities are opening up with government agencies or international agencies that are engaged in work in the less developed countries.

WHAT IS THE JOB FUTURE FOR INDUSTRIAL HYGIENISTS?

By coincidence, the field of industrial hygiene is similar in size and trends to that of health physics. It appears that there were about 2000 industrial hygienists in the mid-1970s, a population which has doubled to 4000 today, and is expected to rise another 50 percent, to 6000 by the mid-1990s. Also, once again, this growth can be attributed largely to the federal programs which resulted from the crusades of Ralph Nader for more stringent standards in the workplace.

CATEGORICAL SPECIALISTS AND GENERALISTS

Despite the trend towards most environmental professions becoming more *interdisciplinary/integrated/involved*, much education and practice still are basically disciplinary. However, in the environmental health field, that situation is changing. This is shown by the movement to classify workers, both specialists and generalists, by the type of environmental health *problem* on which they concentrate. Thus we have problem-oriented, rather than discipline-oriented, personnel working on *air pollution, water pollution, noise, pesticides, solid wastes, radiation, toxic substances, hazardous wastes, occupational health and safety*, and the like. Such a specialist or generalist—who might be called by the name of the problem, plus a word like "program officer," "manager," or "specialist"—may: (a) identify and measure chemical pollutants; (b) determine the effects of such pollutants on biological systems and inorganic materials; (c) establish criteria and standards for control measures; (d) control sources of pollution through enforcement of regulations; and (e) coordinate and integrate program activities with diverse but related industrial and governmental programs and agencies.

These jobs present many opportunities for graduates of the environmental studies curricula described in Chapter 2. They can be stepping stones for B.A. or B.S. graduates, providing practical experience upon which one can design a graduate curriculum leading to any other professional job in the environmental sciences. Thus, one who spends a year or two as an air pollution or noise control specialist might aspire to take a master's degree in biology, chemistry, health physics, or business administration. One who follows such a sequence would illustrate what most new environmentalists can expect in their careers: alternating periods of employment and education, each opening up new horizons at any stage of an environmental career.

How many categorical participants in environmental health programs are there? The author's best guess, based on a few studies and many assumptions, is approximately 100,000, or double the 50,000 estimated in the mid-1970s. Assuming that much of this demand will not continue at the same rate, we would project that 110,000 such jobs will exist in the early 1990s.

PARAPROFESSIONALS

We first discussed paraprofessionals in Chapter 3. They are particularly important, and well represented, in environmental health. Paraprofessionals work in water supply, solid waste management, air pollution control, and waste water treatment, usually for a local level of government. They also work for industry, on the local level at industrial plants' water pollution control facilities, or as sales and service representatives for equipment manufacturers. Unlike professionals, however, they tend to remain rooted in the same area if not the same community, changing jobs.

What is the job future for technicians and aides? In 1974 the National Science Foundation conducted a survey of personnel in pollution abatement activities and found almost two and one-half

technicians or aides for every scientist or engineer, 320,000 to 135,000. Studies since 1974 indicate that the total of technicians or aides has probably doubled, to 640,000. As capital expenditures for water and waste water treatment facilities pretty much determine how many plants will come onstream during the next decade, only an additional 100,000 jobs of this type can be foreseen for the decade until the mid-1990s, when employment should reach about 750,000.

WHERE SHOULD YOU WRITE FOR MORE INFORMATION?

Air Pollution
Control Association
PO Box 2861
Pittsburgh, PA 15230

American Association of
Occupational Health Nurses
75 Madison Ave.
New York, NY 10016

American Industrial Hygiene
Council
475 Wolf Ledge Rd.
Akron, OH 44311

American Institute of Physics
335 E. 45th St.
New York, NY 10017

American Medical Association
535 N. Dearborn St.
Chicago, IL 60610

American Osteopathic
Association
212 E. Ohio St.
Chicago, IL 60611

American Public Health
Association
1015 15th St., NW
Washington, DC 20005

American Public Works
Association
1313 E. 60th St.
Chicago, IL 60637

American Society of
Civil Engineers
345 E. 45th St.
New York, NY 10017

American Veterinary
Medical Association
930 N. Meacham Rd.
Schaumburg, IL 60196

American Water Works
Association
6666 W. Quincy Ave.
Denver, CO 80235

Association of Environmental Engineering
Professors
c/o Prof. Benjamin C.
Dysart III
Environmental Systems
Engineering
Clemson University
Clemson, SC 29631

Engineering Council for
Professional Development
345 E. 47th St.
New York, NY 10017

The Environmental Industry
Council
1825 K St., NW
Washington, DC 20006

Environmental Management
Association
1701 Drew St.
Clearwater, FL 33515

National Association of
Environmental Professionals
PO Box 1223
Alexandria, VA 22313

National Environmental
Health Association
1200 Lincoln St., Suite 704
Denver, CO 80203

National Society of
Professional Engineers
2020 K St., NW
Washington, DC 20006

Water Pollution Control
Federation
2626 Pennsylvania Ave., NW
Washington, DC 20037

Overleaf: Careers in conservation and management of natural resources often require proficiency in surveying and mapmaking.—Photo: Soil Conservation Service, U.S. Department of Agriculture.

CHAPTER 5

RESOURCES AND RECREATION

The forest resources of our country are already seriously depleted. They can be renewed and maintained only by the co-operation of the forester and the practical man of business.–President Theodore Roosevelt in 1903

PROFESSIONS COVERED

Agricultural Sciences
Fisheries Conservation
Forestry
Range Management
Recreation
Soil Conservation
Wildlife Conservation
Zoo and Aquarium Management

President Teddy Roosevelt chose as the first Chief Forester of the nation Gifford Pinchot (1865-1946). In so doing, the President acknowledged the need for professionals in high positions to make conservation policy and to administer conservation programs. Pinchot, you see, was the first American to hold a degree in forestry. His philosophy was: "Conservation means the wise *use* of the earth and its resources." (Emphasis added.) Poet John Muir (1838-1914), on the other hand, believed with Henry David Thoreau (1817-1860) that, "In Wildness is the *preservation*

of the World." Thus, Pinchot and Muir became the symbolic leaders of opposing camps—users vs. preservers—which have been engaged in continuous conflict since the twentieth century began.

HOW DO WE FEEL ABOUT OUR NATURAL HERITAGE?

Over the years, we Americans have preserved and dedicated to public use or perpetual protection more irreplaceable forests, parks, refuges, prairies, wildlands, marshes, and open spaces than have the people of any other nation. At the same time, we have harvested the timber to build our houses, mined the ore to make our automobiles and used other lands to establish our cities and suburbs. Although the conflict between value systems in use of the land continues, since 1970 the new environmentalists have "won" more often than ever before. From 1950 to 1975 The Nature Conservancy acquired, through gifts and purchases, 700,000 acres of lands considered to be "special places." Then, in only five years more, 1975-1980, it acquired another one million acres. Federal natural lands in 1975 consisted of less than 800 million acres until the Congress, after an intensive battle in 1980, voted overwhelmingly to set aside for wildlife and limited mineral development over 100 million additional acres of Alaska. That's an area larger than California.

States, countries, cities, and nonprofit organizations own millions of additional acres of open space dedicated to public use. The gatekeepers of much of this treasury are the Forest Service of the U.S. Department of Agriculture and four agencies of the U.S. Department of the Interior: Bureau of Land Management, Fish and Wildlife Service, Heritage Conservation and Recreation Service, and National Park Service. Each of those agencies has a different primary objective. Together, they all manage lands under their jurisdiction for "multiple use" of outdoor recreation and natural resources. The resources include, besides air and water, "the four F's"—furs, fins, fields and forests.

Consider a career in conservation, and you have a wide range of occupations at various levels from which to choose. In general, you should have a sincere interest in the renewable environment. It would not be too much to ask that you love the land and its creatures as Thoreau, Pinchot, and Muir loved them. You also should enjoy working with people, for our natural resources cohabit the earth with people—it is a *human* environment. You should be dedicated to public service, for you would be an outfront, more often than a behind-the-scenes, public servant. You should be versatile, for you would perform a variety of duties. One day you might be fighting a forest fire; the next you might be explaining conservation principles to a junior high class. You would be, in part, scientist making observations and conducting experiments. And you would be, in part, manager manipulating and maintaining the health of ecosystems—in another sense, a practical ecologist. Your work would be *interdisciplinary/integrated/involved*. It would be problem-focused, concerned primarily with ends—not discipline-focused, concerned primarily with means.

Now here is a triple irony. First, while the environmental movement has brought a boom to environmental health, it has caused no comparable expansion of environmental resource conservation. (An exception is in the agricultural environment, discussed below.) Second, the public obviously values the environment and its publicly owned natural resources. (One type of evidence is the steady acquisition and preservation of new areas. Another is ever-growing public use, to the damaging point of overcrowding and overuse, of many public areas such as national parks.) Third, the inertia in federal support of, and resulting lack of growth in, natural resource management is a contradiction of the growing public support, just mentioned, for acquiring vast new resource territory for an unexpanding staff to manage.

Resources and recreation is a neglected area of national concern. Professionals in these fields frequently are overburdened

and underpaid. The National Wildlife Federation, which for a quarter of a century has conducted an annual survey of employment and compensation in the fields of fish and wildlife management, advises:

> The outlook for federal jobs is not promising, with most agencies facing budgetary and personnel cutbacks. As usual, some limited recruitment can be expected to fill positions made vacant through attrition and transfer, and, as always, competition will be keen. There are simply not enough vacancies to accommodate all individuals seeking jobs.
>
> Although the job outlook in the federal agencies appears to be rather bleak, individuals interested in federal agency employment should continue vigorous pursuit of career goals. Job opportunities sometimes develop when or where least expected. Frequently those who seek jobs most diligently are eventually rewarded for their extra efforts.

Yet the job future varies widely, from the agricultural sciences, which are healthiest, to the conservation disciplines, which are subject to wide swings in federal and state funding.

AGRICULTURAL SCIENCES

American agriculture is the most efficient in the world. Per capita, it is the most productive segment of our economy. Credit for American agriculture's accomplishments goes largely to the land grant colleges and universities with their network of cooperative state research and extension services.

American agriculture is changing in response to changing social needs and demands. Its overdependence on chemicals is being questioned by environmentalists, and many farmers are moving into integrated pest control, using insecticides as little as possible. Early in the 1980s organic farming and gardening was being pro-

moted, for the first time, by the U.S. Department of Agriculture, and thousands of farmers were adopting its principles. Farmers were widely adopting new techniques of energy conservation in agriculture, at the same time making a growing contribution to energy supply through increased production of grain for alcohol that can be combined with gasoline to produce gasohol.

In the value system of environmentalists, all of those trends are "good." They add to protection and enhancement of the environment and its resources. They efficiently use the land and its resources for the production of food and fiber—and now, fuel. And they provide interesting, rewarding work for many. As not all persons in the health professions are regarded as being in environmental health, not all of those in agriculture are in the protection and enhancement of the environment. The Bureau of Labor Statistics estimates that agriculture employs more than three million persons. For our purposes we group together the scientific, technical, and professional occupations dealing with agriculture, its products or the farm population and call their practitioners *agricultural scientists.* The field consists of three major parts:

- Those who conduct research on the production, distribution, and use of crops and animals for food and fiber. They may work at colleges of agriculture, cooperative research stations, in "agri-business" or for other federal, state or private agencies.
- Those who formally teach the agricultural sciences at land grant colleges and universities or other institutions offering agricultural studies.
- Those who do educational work in fields such as agricultural production and home economics and may conduct educational programs through youth groups such as the 4-H clubs. These are the *county agents* and *home economists* engaged in *extension* work, a cooperative effort of federal, state, and local governments which has had enormous impact on American agriculture and the lives of all Americans for more than a century. Hundreds of thousands of volunteers,

including youth, further extend this outreach to provide services to millions of Americans, urban as well as rural.

The U.S. Department of Agriculture's Science and Education Administration operates eight major research centers and more than 150 other research facilities, located in virtually all the states. In addition, it sponsors research in hundreds of colleges.

Agricultural research embraces animal and plant production and protection; use and improvement of soil, air, and water; development of new and improved foods, feeds, fabrics, and industrial products; and basic research on human health and safety.

Become an agricultural scientist and you might study the effects of changing climate and weather on agricultural production; work to eliminate the sources of pollution that result from agricultural practices; explore uses of fuel made from plant products; search for ways to reduce the use of fossil fuels in producing crops and livestock; test the possibilities of aquaculture (farming systems for plants and animals that live in water); find safe, feasible ways to use organic wastes; explore biological (non-chemical) pest control methods; promote urban and agricultural integrated pest management practices; develop methods for assuring the safety and quality of food and food products; conduct basic and applied research in the animal and plant sciences; do controlled experiments in human nutrition and diet; develop community resources in rural areas; conduct home audits for energy conservation; and develop systems to assist the public in coping with natural disaster emergencies.

A list of the principal disciplines involved in the agricultural sciences would include the following.

- The *agricultural chemist* conducts research to improve crop yield and promote soil conservation; develops chemical compounds to control insects, weeds, fungi, and rodents; and experiments to determine proper usage of fertilizers or to investigate the problems of nitrogen fixation in soils.
- The *agricultural economist* deals with problems related to

production, financing, pricing, and marketing of farm products; cost-benefit analyses for evaluating agricultural programs; and the effects of new technology on the supply of, and demand for, agricultural products.

- The *agricultural engineer* designs agricultural machinery and equipment and develops methods that will improve the production, processing, and distribution of food and other agricultural products. This is the only category of agricultural employment which the Bureau of Labor Statistics expects to grow faster than the average of all occupations through the 1980s. Part of this increased demand for agricultural engineers will be created by industry's response, for example, to the energy crisis, and by new emphasis on resource recovery and recycling. Biomass, in the form of wood pulp, sawdust, and chips, is being researched by agricultural engineers as a promising substitute for fossil fuels. Agriculture is a major consumer of energy, and ag engineers are contributing to the reduction of energy demand in the production and processing food and fiber. With approximately 15,000 professionals, agricultural engineering is one of the largest segments of agricultural science. It is the only such profession, too, most of whose members work in the private sector. Major employers are manufacturers of farm equipment and machinery, electric utility companies, and producers and distributors of farm equipment and supplies. Fewer than 500 are employed by the federal government, mostly in the Department of Agriculture.
- The *agronomist* conducts experiments in field crop problems, develops new methods of growing crops to increase yields and to improve quality, and studies the effect of climates on crop production. The *horticulturist* works in a subspecialty of agronomy with orchard and garden plants—trees for shade, fruit, and nuts; vegetables; and flowers—and the utilization of plant communities for the beautification of human communities.

- The *animal physiologist* studies the functions of various parts of the bodies of livestock, whereas the *animal scientist* is concerned with the production and management of farm animals, i.e., the selection, breeding, feeding, and marketing of farm animals, plus their housing, sanitation, nutrition, and parasite and disease control. Yet again, the *veterinarian* (already discussed in Chapter 4) is responsible for maintaining animal health and treating animal disease (and may work with animal physiologists and animal scientists in research).
- The *entomologist* concentrates on insects that injure plants and animals at any stage of their growth and development; this includes developing new pesticides that are less harmful to humans and less persistent in the biosphere than are the organic chemicals and developing integrated pest management practices, especially non-chemical methods.
- The *food chemist* may specialize in one kind of food; say, dairy products or cereals. (See Chapter 3 for description of the environmental chemist.)
- The *geneticist* develops strains, varieties, breeds, and hybrids of plants and animals that are better suited for food and fiber than those previously available. (A subspecialist, the human geneticist, is not regarded as either an agricultural or an environmental scientist, but a basic scientist.)
- The *microbiologist* studies bacteria and other microorganisms to better understand their relation to human, animal and plant health. The microbiologist also is the key scientist in the development and production of alcohols (including gasohol, already mentioned), amino acids, antibiotics, sugars and vitamins.
- The *nutritionist* is concerned with how the body utilizes foods and nutrients, and the relation of those substances to human health and disease. One subspecialist, the *human nutritionist*, works on problems of human health, food, and the social, economic, and cultural aspects of peoples' diets, while another, the *animal nutritionist*, works on the diet of

livestock or domestic animals.

- The *plant pathologist* studies the causes of plant diseases.
- The *plant physiologist* studies the structure of plants and factors that affect their growth—such matters as respiration, metabolism, and reproduction.
- Finally, the *rural sociologist* (a social, not a physical, scientist) is concerned with the structure and functions of rural human society, from the individual, through farm families, to the institutions of their isolated and not-so-isolated rural communities.

WHAT EDUCATION WOULD YOU NEED TO BE AN AGRICULTURAL SCIENTIST?

Of all the professions considered to this point, only the last four in Environmental Health generally can be practiced with education only to the bachelor's level. Many agricultural science professions also can be entered with only the bachelor's degree, sometimes with a major in environmental studies, especially one from a college of agriculture and natural resources.

One of the fastest growing areas of higher education—as a direct consequence of the environmental movement—is colleges of agriculture and natural resources. During the decade of the 1970s, when college enrollments generally were dropping and many schools began recruiting students, the nation's agricultural colleges had all the students they could accommodate. That was attributable to a number of factors:

1. Young persons are motivated towards environmental careers because of their concerns for the environment, and colleges of agriculture broadened their curricula to become "environmental universities."
2. Young persons see the connections between and among environment, agriculture, food, health, and standards of living.

3. The new environmental universities offer *interdisciplinary/integrated/involved* studies to match the career interests and demands of young persons and their ideals.
4. This kind of education goes along with other interests of young persons such as "the new ruralism," defined as the population migration from the cities and suburbs to rural areas, and from the urban centers of the East Coast to the warmer, cleaner, less-crowded counties of the Sun Belt, the southern tier of states westward from Florida to California.
5. Finally, least tangible of all, there are things that make many people happy, and one is isolation—or at least distance from large numbers of fellow human beings. Living and/or working on a farm also provides satisfactions to be found nowhere else, including intimate contact with the soil, growing things, animals, plants and the weather.

In many states, especially outside the populous East Coast, the state universities (among them, some of those described in Chapter 2) are larger and more prestigious, with higher academic standards than most private universities. Any of the specialists named above whose titles include the words "agricultural," "animal," or "rural" almost certainly would have attended a state university college of agriculture, for graduate work if not undergraduate. But a holder of a bachelor's degree from any college or university can enter almost any of these professions. A master's degree is always desirable, and, especially to teach at the college level, a doctorate is needed.

WHERE WOULD YOU WORK AS AN AGRICULTURAL SCIENTIST?

For the reasons listed above the graduate of an agricultural college has an advantage over the graduate from a narrower disci-

plinary curriculum, or even the liberal arts graduate. He or she can work in the expanded areas of agriculture per se, or apply the education to an appropriate job unrelated to agriculture. This could be literally anywhere, from Park Avenue in New York to a village in the Philippines.

Let's assume, however, that the agricultural environmentalist stays in the field after graduation. It would probably be in a job for the U.S. Department of Agriculture, a state department of agriculture, a college or university, or in agri-business. We have used that term before; it means industries that supply raw materials to farmers and process and distribute agricultural products, or in another way are related to agriculture.

WHAT IS THE JOB FUTURE FOR AGRICULTURAL SCIENTISTS?

The author cannot be as pessimistic about the job future for agricultural scientists as the Bureau of Labor Statistics is about agriculture itself. True, the number of farms continues to decline. Fewer farms means larger farms, requiring more and larger machinery and fewer farm laborers. As we have seen in many other fields, notably computers and the telephone system, automation reduces the number of "hands" needed but may drastically increase the number of "brains" needed. Besides, people have to eat, they like to eat well, and they will pay well to eat well.

The agricultural sciences employed an estimated 50,000 professionals in the mid-1970s. There are strong indications that employment today is 75,000. A straight-line projection would suggest probably employment of 100,000 professionals by the mid-1990s.

We believe such a level is conservative, in part because of the five factors to which we attributed the rise in agricultural college enrollments. Further explaining the expected growth in

job demand for the graduates of these programs are three additional factors:

1. Agriculture traditionally has had a strong rural constituency expressed through farm families and their votes, their congressional representatives, the Department of Agriculture, and the powerful lobbies of agri-business enterprises. While the major focus of this opinion-molding and lobbying effort is on economic matters such as subsidies, government markets and price supports, the tools of this political power could easily be turned to other objectives–what better objective for the future of agriculture than job creation in agricultural sciences?
2. Now that farmers, the traditional products of agricultural colleges, are being joined in their alumni groups by large numbers of science graduates who have no intention of becoming farmers, the two interest groups–the so-called "farm bloc" and the broader environmental community–could join forces to multiply the political power either has enjoyed alone.
3. Surprisingly, there is a third group of citizens with a natural affinity to, and interest in, both agriculture and environment–and that is women. Women comprise about one-third of the total enrollment in agricultural colleges. They are studying everything from agricultural engineering to zoology.

Talk about synergism! (In biology, the action of two or more substances or organisms to achieve an effect of which each is individually incapable.) Environmental problems affect everyone. Cooperation is a better way to solve them than competition. Furthermore, many environmental problems just naturally involve agriculture and agricultural technologies. Food and nutrition are frequently alluded to. Equally essential to life and society is energy. The agricultural sciences have untapped contributions to make to solar energy systems, wind energy applications, aquaculture, other renewable energy forms such as biomass, gasohol and energy conservation techniques.

FISHERIES CONSERVATION

As a *fisheries conservationist*, you would be involved in a field as old as biblical times yet more needed today than ever. Almost three-fourths of the earth's surface is covered by water. Millions of people who live along the shores of the earth's oceans, seas, bays, lakes, rivers, and streams depend on fish for food, perhaps as their only source of life-supporting protein. In this country alone, more than 35 million sport fishers spend $5 billion and 640 million fishing-days per year enjoying the sport. Over one million farm ponds are managed for fish production and angling. By the year 2000, an estimated 63 million anglers are expected to fish 1.3 billion days per year!

What does a fisheries conservationist do? Become one, and some of your work would resemble that of many other life scientists: you might conduct research in physiology, ecology, population dynamics, water quality, limnology, marine biology, etc. You might be concerned with resource management: maintaining population balances through eradication and stocking programs, investigation of fish kills, and habitat and population surveys. You might be in program administration, planning and coordinating programs, budgeting and expending funds, supervising personnel, etc. You might be in information and education. Your work would differ from other scientists' in being focused in the marine or aquatic environment. Your unique function might be fish culture. If you should work in a hatchery, you would raise fish for stocking, for the market or the live bait industry.

WHAT EDUCATION WOULD YOU NEED TO BE A FISHERIES CONSERVATIONIST?

As in biology and ecology, fisheries conservation occupations require a good high school education, including physics, chemistry, biology, English, communications, mathematics, and a foreign

language. Some community colleges offer the A.S. degree in fisheries. You can get good preparation at almost any four-year college or university by taking a degree in biology or zoology. Study, for starters, the principles of comparative anatomy, microbiology, genetics, chemistry, mathematics, computer programming, and statistics. Continue to hone your skills in communications, English, and the humanities.

If you prefer a specialized curriculum, seek out one of the approximately 125 colleges or universities offering specialized programs in fisheries science or conservation. There you can plan an M.S. as well as a B.S. program. If you plan to teach and do research, a Ph.D. is mandatory.

WHERE WOULD YOU WORK AS A FISHERIES CONSERVATIONIST?

A majority of fisheries conservationists work for the federal, state, provincial, and territorial government agencies of the United States and Canada. Seven agencies of the U.S. Department of the Interior among them employ half of the U.S. Government's roster. Interior's Fish and Wildlife Service is the nation's, probably the world's, largest employer of fisheries conservationists. The National Oceanic and Atmospheric Administration of the Department of Commerce is the second largest employer of (primarily salt-water) fisheries conservationists. The Environmental Protection Agency is third, and agencies of the Department of Agriculture fourth. A smattering work for six other agencies of the U.S. Government and, in Canada, for the Fisheries and Marine Service, Department of the Environment. There are about two dozen cooperative fishery units such as hatcheries attached to universities, and all are significant employers of fisheries biologists and related personnel. A few international agencies, such as the Food and Agriculture Organization (FAO) of the United Nations, hire

fisheries scientists. Others are employed by private industries to develop food products or compile data and prepare environmental impact statements or manage aquatic properties. A few are hired by private clubs and organizations to do a variety of work from stream management to public relations.

WHAT IS THE JOB FUTURE FOR FISHERIES CONSERVATIONISTS?

Carl Sullivan, executive director of the American Fisheries Society, forecasts that fisheries employment opportunities, particularly in the public sector, will be scarce in the short term. The National Wildlife Federation's report "Compensation in the Fields of Fish and Wildlife Management" elaborates:

> No one knows exactly how many fisheries biologists/scientists are employed in North America, but many informed persons consider 15,000 to be a reasonable estimate in the mid-1980s. If the average working life of a fisheries professional is 30 years then approximately 500 jobs would open each year. We do not know exactly how many graduates are being produced each year, but it is undoubtedly far more than 500 so many must search for employment with the private sector or in other fields. There are substantially fewer fisheries opportunities in private industry so opportunities will be hard to come by.

This author would estimate modest growth, by the mid-1990s, to not more than 17,500 fisheries conservationists, compared to about 14,000 in the mid-1970s.

The NWF report makes a few more observations: state and federal agencies are caught in the inflation squeeze, and new jobs are nearly non-existent. More and more states are receiving mandates from legislatures or governors to employ residents first.

New bachelors or masters graduates, finding no jobs at home, may face extended searches. Few bachelors-level jobs are advertised; rather, they are snapped up from unsolicited applications.

Still interested in considering fisheries conservation? Then by all means go to it! Remember that Rachel Carson, the author of *Silent Spring* and *The Sea Around Us*, was a fisheries biologist, a teacher, and a researcher employed by the U.S. Fish and Wildlife Service for many years, as well as a brilliant, accomplished and successful writer.

Jacques-Yves Cousteau continues to romanticize the oceans and their resources, and the Sea Grant Program of the National Oceanic and Atmospheric Administration continues to support education and research for the field. Fisheries certainly will not disappear, and inevitable modest growth to 1990 could turn into a boom if someone of your generation (you?) should become technically qualified and then decide to become the Ralph Nader of natural resources, the people's advocate of food from the seas.

FORESTRY

As a *forester* you would manage, develop, and use the forest lands and all their resources. Forestry, in the definition of the Society of American Foresters (SAF), is "the science, art, and practice of managing and using for human benefit the natural resources which occur on and in association with forest lands."

The Society was founded in 1900 and was only three years old when President Theodore Roosevelt spoke at its meeting at the beginning of this chapter. "Foresters are experts on the interrelationship of forest soil, air, water, trees and other plants, people, wildlife and domestic animals," continues a careers publication of the SAF, pointing up the *interdisciplinary/integrated/involved* nature of the profession.

What does a forester do? Become one, and some of your duties would resemble those of any other life scientist—you might do research or teach forestry; or administer forest properties or programs of government agencies or forest companies. You might be in information or education. One characteristic of your work distinguishing it from others' is that it would be focused on the forest environment. You, uniquely among conservationists, would be concerned with the ecology and the economics of forestry. This means that you would be skilled in preventing damage to forest resources from insects, diseases, and fires. You would plan and prescribe forest land uses and practices. You would supervise others—timber harvesting crews, fire fighters, tree planters, and recreational supervisors as well as trainees and students backing up the professionals and technicians on the team.

In common with the other conservation occupations, forestry requires scientific curiosity, good health, and a preference for outdoor activity. The forester must be able to excel at the extremes of loneliness—perhaps for weeks without seeing another human being—and gregariousness—for at other periods the duties might involve constant meetings and public speaking.

WHAT EDUCATION WOULD YOU NEED TO BE A FORESTER?

The professional forester must have at least a bachelor's degree in forestry from one of the approximately 50 schools of forestry. If possible, you should consider the M.S. or Ph.D., especially if you intend to concentrate on teaching and research. The curriculum includes a well-rounded education in the biological, physical, and social sciences. Specialized studies include concentrations in ecology, forest economics, forest protection, silviculture, resources management and use, dendrology, forest measurements, forest policy, and forest administration. Forestry

schools usually require the student to spend one summer in a college-operated field camp and encourage spending other summers in related work, if possible.

WHERE WOULD YOU WORK AS A FORESTER?

An estimated 50 percent of the professional foresters work for public agencies—federal, state, and local. Some 37 percent are self-employed by private and industrial concerns, mainly pulp and paper, lumber, logging, and milling companies. The remaining 13 percent teach, do research or are in graduate school.

The principal employing organization is the U.S. Forest Service of the Department of Agriculture. The Soil Conservation Service also is a major employer. Many foresters also work in components of the Department of the Interior: Heritage Conservation and Recreation Service, U.S. Fish and Wildlife Service, and National Park Service. A forester employed by a state would work in the comparable state agency.

WHAT IS THE JOB FUTURE FOR FORESTERS?

Since the mid-1970s when there were 24,000 foresters, the profession has grown slowly, to only about 25,000 in the mid-1980s. After analyzing BLS statistics and other evidence, this author expects employment of professional foresters to rise only slightly more rapidly, to about 27,500 a decade hence. In recent years, however, the number of degrees in forestry has exceeded occupational requirements, creating competition for jobs. If the number of degrees granted each year remains at present levels, competition is expected to persist. Opportunities will be better

for those who can offer an employer either an advanced degree or several years' experience.

FOREST TECHNOLOGY

Unlike some other natural resource professions, forestry includes a large paraprofessional category, the *forestry technician*. He or she assists professional foresters in the care and management of forest lands and their resources.

Technicians help estimate present and potential timber production in a certain area and measure logs to determine how much lumber they will yield. If new roads are needed to make the timber accessible for cutting, aides may work as part of road building or surveying crews. They inspect trees for diseases and other problems and keep records of their findings. On simple watershed improvement projects, they install, maintain, and collect records from rain gauges, streamflow recorders, and instruments that measure soil moisture.

They also help to prevent and control fires. They give fire prevention information to people using the forest and lead firefighting crews if a fire occurs. After fires are extinguished, they take inventory of burned areas and supervise the planting of new trees and shrubs to restore the forest.

Most persons qualify for beginning jobs as forestry technicians by completing a one- or two-year course in a community college, about eighty of which offer such a program.

About 13,000 forestry technicians and aides work year-round, with approximately the same number finding temporary employment during the summer or during the spring and fall fire seasons. Most of the temporary workers work for the federal or state government agencies.

Nearly half of the year-round employees work in private industry, mainly for logging, lumber, and paper companies.

Reforestation projects of mining, oil, and railroad companies—as well as employment in tree nurseries—account for the remainder in private industry. The Forest Service of the Department of Agriculture is the principal federal employer.

Full-time employment is expected to rise, by the mid-1990s, to 15,000 full-time forestry technicians and aides, with the same number of part-timers.

RANGE MANAGEMENT

As a *range manager*, you would be responsible for managing, developing, and protecting the rangelands. What is rangeland? You have seen it in Western movies on TV: it is native grazing land. It covers about 47 percent of the entire land area of the earth. It is the largest single category of land in the U.S.—more than one billion acres, mostly in the western states and Alaska.

Rangelands contain many natural resources: grass and shrubs for animal grazing, habitats for livestock and wildlife, facilities for water sports and other kinds of recreation, and areas for scientific study of the environment. These renewable resources can yield their full potential only if properly managed.

The range manager—sometimes called *range conservationist, range scientist* or *range ecologist*—manages, improves, and protects this ecological system. Become a range manager and you would be responsible for deciding the number and kind of animals to be grazed. You would be a practical ecologist, selecting the best season for grazing while conserving soil and vegetation for other uses, such as wildlife grazing, outdoor recreation, watersheds and growing timber. You would be a practical economist, optimizing the production of livestock and sometimes timber and commercial crops.

You would restore or improve rangelands through techniques such as controlled burning, reseeding, and the biological, chemical

or mechanical control of undesirable plants and would have the satisfaction of seeing your surroundings change as a result of your work. You might plow up rangelands covered by natural sagebrush vegetation and reseed them with more productive grass.

Because of the multiple use of rangelands, you might spend much of your working time performing the duties of a forester, wildlife conservationist, watershed manager, recreationist or even a farmer! You might have to provide animal watering facilities, control erosion, and build pens and fences, for example.

WHAT EDUCATION WOULD YOU NEED AS A RANGE MANAGER?

A bachelor's degree in range management is the normal educational qualification for a professional position in the field. A degree in a closely related field such as agronomy or forestry, including courses in range management, may be accepted. Approximately 20 colleges and universities offer degrees in range management; all of them offer the master's degree; some schools offer a Ph.D. in range science or a related field.

A degree in range management requires a basic knowledge of biology, chemistry, physics, mathematics, and communications skills. Advanced courses combine plant, animal, and soil sciences with principles of ecology and resources management. Desirable electives include economics, computer science, forestry, wildlife, and recreation.

WHERE WOULD YOU WORK AS A RANGE MANAGER?

The majority of range managers work for federal, state, and local governments, almost exclusively in the western half of the U.S. or Canada. Federal employees work mainly in the Forest

Service and Soil Conservation Service of the Department of Agriculture and the Bureau of Land Management of the Department of the Interior. State and provincial game and fish departments employ many range managers.

In the private sector, livestock ranches are the largest employers. Some range managers work as rangeland appraisers for banks and real estate firms. Others manage their own lands. A few teach and do research at colleges and universities or work overseas with U.S. or United Nations agencies.

WHAT IS THE JOB FUTURE FOR RANGE MANAGERS?

Employment opportunities for range managers are expected to grow faster than the average for all occupations, through the mid-1990s. The growing demand for red meat, wildlife habitat, recreation, and water, as well as increasing environmental concern should stimulate the need for more range managers. Since the amount of land cannot be expanded, range managers will need to increase the range ecosystem's productivity while maintaining its environmental quality. Also, range managers will be in greater demand to manage large ranches, which are increasing in number. Some of these spreads in the western United States are being acquired by super-rich Middle Eastern oil potentates, as investments in a country which they consider safe, prosperous, and inviting. Wealthy Americans, as well, are buying ranches for sport, vacation, and investments.

As oil and coal exploration accelerates, private industry will require many more range specialists to reclaim or restore mine lands to productivity, as required by federal law.

Range management is the smallest natural resource profession, employing about 3500 professionals in the mid-1970s. Federal hiring for these activities depends heavily upon legislation concerning the management of rangeland, as well as budgetary

limitations, personnel ceilings, and program priorities. It is fair to assume, however, that present employment of about 4000 will rise, by the mid-1990s, to at least 5000.

RECREATION

Have you, perhaps from early childhood, developed an interest and skill—horseback riding, archery, swimming, arts and crafts or identification of trees, birds or other elements of nature? If so, you have an advantage in applying for a recreation job. Have you taught or coached others? You can apply any such skill acquired in youth work, for the Girl Scouts, Boy Scouts, Camp Fire Girls, 4-H, YMCA, YWCA, YMHA, Future Farmers, Future Homemakers, Sunday school or fraternal organizations.

With such experience, you should, by the middle school years, try to attend a boarding camp, day camp or organized recreation center activity during the summers. By the high school years, hopefully, you will have developed, through study and practice, expertise in one or more activities which specially interest you.

Perhaps the sum of those experiences is that you are considering a career in recreation. As a *recreationist* you would be responsible for planning, managing or conducting a variety of physical, social, cultural, and mental activities which the public undertakes for pleasure, or responsible for developing the facilities needed for them. The field embraces leisure pursuits (recreation), areas and facilities used in leisure pursuits (playgrounds, parks, gymnasiums), and the functions necessary to assure harmonious use (teaching, coaching, guiding, etc.)—in short, any activity which re-creates people. Recreation can be enjoyed everywhere in the city, suburbs, rural areas or wildlands—anywhere there are people.

While the emphasis in many recreation programs is on outdoor activity, the recreationist may be engaged in directing activities which can be enjoyed indoors: dancing, music, drama, arts and

crafts, games, physical fitness exercises, and hobbies. Skill and talent obviously are needed. If you excel in dance, music or sports, you may teach and direct such activities. Not everybody can be equally competent along such lines, but the professional recreation field is broad enough to encompass a variety of interesting, satisfying jobs.

You will spend more of your lifetime at leisure pursuits than at anything else except sleeping and eating. More than one-third of your life will be free, unoccupied time. Only you can choose how to use it. Workweeks are growing shorter; holidays with pay are increasing; vacations are getting longer. You can retire younger than your parents could. All of those trends are creating demand for recreationists.

Certain other trends are contributing to this demand as well. Federal, state, and local government appropriations for parks and recreation have been climbing. Investments in private outdoor recreation are soaring. New specialties—recreation for those in hospitals, prisons, and ghettos—are receiving attention. All types of recreation careers offer challenges to those interested in serving their fellow human beings.

WHAT EDUCATION WOULD YOU NEED TO BE A RECREATIONIST?

In 1965 there were about a hundred colleges and universities offering curricula in recreation and parks. Today there are more than 300. The greatest growth has been in community colleges offering two-year programs. About one-third of the students are women.

A bachelor's degree in recreation is the normal educational qualification for a professional position in the field. A degree in a closely related field such as education, physical education or psychology may be acceptable. Some universities offer doctorates.

You should take basic courses in education, history, economics, natural and social sciences, psychology, health sciences, and other subjects which will increase your understanding of society and how it functions. About half of your education should emphasize learning about and working with people. The other half can deal directly with recreation or parks. In those courses you will be exposed to the history of the recreation movement, the kinds of agencies in the field, the dynamics of recreation leadership, and, in depth, the skills of recreation programming, park management, ecology, natural resources, and program administration.

WHERE WOULD YOU WORK AS A RECREATIONIST?

The field of recreation is newer and less formally organized than any of the specialties of natural resources management. Consequently, defining it is more difficult. The majority of professionals and paraprofessionals are in the public sector—national, state, regional, and local park and recreation departments. You probably would start out in the field with the local public park department, the largest category of employer of trained recreation personnel. According to one survey, about 12 percent of the total work in the private, profit sector and 1 percent in commercial recreation.

A promising new specialty is recreation therapy, whose graduates are employed in hospitals such as those of the Veterans Administration system, the armed forces, country clubs, health spas, youth organizations, summer camps, and many other places.

Here is a new trend: look at those very special places where not everybody would want to work, but which offer particular challenge to serve one's fellows: nursing homes, mental hospitals,

migrant workers' camps, rehabilitation centers, drug abuse detention facilities, and prisons. You might be especially attracted to working with the elderly, the retarded, the physically or mentally handicapped or others who need compassion with their recreation.

The armed forces employ as recreationists both military personnel and, increasingly, civilians, who now outnumber uniformed recreation professionals.

Look into private sector employment, which is small but growing: private recreation clubs and country clubs, retirement and second-home communities, land development companies and resorts, tourism agencies, airlines, steamship cruise lines, and woodpulp firms. These offer jobs which may be good mixtures of work and play, the chance to travel, to meet interesting people, and to broaden your experiences.

WHAT IS THE JOB FUTURE FOR RECREATIONISTS?

In the mid-1970s there were an identified 250,000 recreationists. The only projections are out-of-date. We can only assume that our estimates of the size of the field, 275,000 professionals and paraprofessions, is reasonably accurate. Certain trends such as rising average longevity, falling average age of retirement, and general economic prosperity—all lead one to believe that job prospects for recreationists will rise, too. The author believes that the field will employ at least 290,000 by the mid-1990s.

SOIL CONSERVATION

As a *soil conservationist* you would be responsible for supplying farmers, ranchers, and others with technical assistance. Such

landowners are organized under state law into soil conservation districts. While these people would be your "clients," the chances are that you would work for the federal government in helping them to adjust land use, protect land against soil deterioration, rebuild eroded and depleted soils, and stabilize runoff and sediment-producing areas. You also would help improve cover on lands devoted to raising crops and maintaining forests, pasture, and rangelands and the wildlife they support. In addition, you probably would help plan methods and facilities for handling water for farm and ranch use, conserving water, reducing damage from flood water and sediment, and draining or irrigating farms or ranches as needed.

As a soil conservationist (or *soil scientist* or *soil engineer*) you would draw maps portraying soil, water, vegetation, and structures. You would compile information including cost-benefit analyses (the costs of various uses and treatment of lands, and the relative benefits to be expected). You would present these maps and plans to the landowner or operator and answer any questions. When the operator had decided on a plan of action for conservation farming or ranching, you would provide any needed counsel and technical advice and guidance on its implementation.

You might work on a special program of the Soil Conservation Service (SCS), such as snow surveys and water forecasting. Each winter SCS personnel cover about 70,000 miles of the western states by skis, oversnow vehicles, and aircraft to measure the snowpack. The data they collect are translated into a water supply forecast for the following spring and summer planting and growing seasons.

New federal anti-pollution laws impose strict controls on sediment, or soil runoff, responsible for much water pollution. So, many states employ soil scientists to inspect large highway and building sites where vegetation has been removed and agricultural lands where fertilizers have been applied, to make sure proper erosion control methods have been used.

WHAT EDUCATION WOULD YOU NEED TO BE A SOIL CONSERVATIONIST?

As a minimum you should have a bachelor of science degree with a major in soil conservation or a closely related area of natural science or agriculture. Courses in chemistry, physics, mathematics, topography, meteorology, agronomy, and related physical and environmental sciences are desirable. As you would be responsible for communicating and interpreting plans and counseling users on their problems, you should take as much liberal arts as your college program permits. This should include English, psychology, speech, and possibly education.

If you were raised on a farm or ranch, you would have an advantage over others in a "feel" for landowners' needs. If you came from the city or suburbs, on the other hand, you would need to compensate for a probable deficiency in "feel" by trying to get summer jobs in rural settings—if necessary, working for room and board to get the experience.

WHERE WOULD YOU WORK AS A SOIL CONSERVATIONIST?

There are about 14,000 soil conservationists, plus another 6,000 soil scientists, up from 12,000 and 5,000 in the mid-1970s. Most of them work for the federal government, mainly the U.S. Department of Agriculture's Soil Conservation Service. Other federal employers are the Forest Service, National Park Service, and Bureau of Reclamation. P- e employment is increasing. Banks, public utilities, real esta . developers, and consulting engineers also employ soil conservationists.

WHAT IS THE JOB FUTURE FOR SOIL CONSERVATIONISTS?

Opportunities for the well-trained soil conservationist are good. Relatively small, and geared to an agricultural economy, the profession is in a good position to grow steadily and become geared to the new technological economy ahead. The rapid expansion of water supply, waste water, and other urban environmental programs has accelerated openings for soil conservationists in urban areas, as has industrial development including the conversion of rural land to industrial parks. Growing demand for new energy sources, for expanding food production, for new housing and new communities, all these factors will require more soil conservationists and related personnel. There are about 14,000 soil conservationists, plus another 6000 soil scientists, up from 12,000 and 5000 respectively in the mid-1970s. A conservative estimate is that, by the mid-1990s, the nation will need 18,000 soil conservationists, plus 7,000 soil scientists.

WILDLIFE CONSERVATION

Wildlife conservation is any human effort to manipulate the natural resources of soil, water, plants, and animals for the purpose of producing optimum numbers of healthy animals to satisfy a combination of ecological, social, aesthetic, economic, commercial, recreational or scientific needs.

As a *wildlife conservationist* you would be concerned with the total ecology—fisheries, forest resources, range, soils, and economically viable facilities. You would be conversant with all the other conservation disciplines, and your daily duties would involve the practice of many of them. You would be responsible

for providing habitat (food, water, and cover) for wildlife in reasonable proximity to human habitation. You might also be engaged in wildlife management–personally handling animals, for example–research, information, education or enforcement of game and fish laws.

Wild animals are part of the heritage of all people. Some species need protection, for they have become scarce (some even extinct), or because their haunts are being destroyed or affected by development. The wildlife conservationist is responsible for programs to protect endangered and rare species, from the whooping crane to the American alligator. There are over 60 birds, animals, and fish on the endangered list. On the other hand, this specialist is responsible for programs to control populations of species whose excessive numbers may cause economic losses to farm or forest crops or to human habitation. These include blackbirds, starlings, rodents, and deer.

Economic significance is another measure of the importance of wildlife conservation. In the U.S. and Canada, an estimated 60 million persons hunt and fish, and millions more travel to see the continent's animal and plant life. Commercial trapping and fisheries also produce millions of dollars of income annually.

WHAT EDUCATION WOULD YOU NEED TO BE A WILDLIFE CONSERVATIONIST?

You can take suitable bachelor's level work, say, in biology, at almost any college or university, and this would be sufficient for a beginning job in wildlife biology. In addition to a thorough grounding in physical and biological sciences, you would need training in such liberal arts as English, languages, history, geography, statistics, and the economics of food and fiber production. While still in high school, you should take as many mathematics, physics, English, chemistry, and biology courses as

you can. The Wildlife Society recommends that you acquire group experience in committee work and meetings and write for high school publications, as well.

If you know upon graduating from high school that wildlife conservation or management is the field for you, you might choose one of the 90 colleges and universities listed by The Wildlife Society in its annual survey of enrollments. The Society recommends graduate work, which is essential if you wish to go into research or some of the broader phases of management and administrative work or teaching. In its annual survey, the National Wildlife Federation covers fifty state universities, primarily one per state but two each in California, Michigan, and New York, which offer degrees in wildlife science.

WHERE WOULD YOU WORK AS A WILDLIFE CONSERVATIONIST?

Most wildlife conservationists in the U.S. and Canada work for the federal government, state or provincial governments or in colleges and universities. Many of these programs are cooperative, that is, funded largely by the U.S. Government but conducted in state facilities by state employees. The U.S. Fish and Wildlife Service of the Department of the Interior is the largest federal employer. Substantial numbers are employed by the colleges and universities. A few are hired by private sportsmen's clubs and organizations.

WHAT IS THE JOB FUTURE FOR WILDLIFE CONSERVATIONISTS?

For many years, the National Wildlife Federation has been our most authoritative source of information about compensation in

the fields of fish and wildlife management. The latest report shows a discouraging job market and a static demand for the near future. Hemmed in by work-force ceilings and budget constraints, many state wildlife agencies have attempted to maintain employment levels constant, despite inflation, by increasing income through raising license fees for hunters and fishers (just as the Postal Service raises postage to remain self-sufficient).

Richard N. Denney, executive director of The Wildlife Society, says in the NWF compensation annual:

> In view of the current and predicted world unrest, as well as the energy shortage, the prognosis for natural resource conservation concerns is not optimistic. However, . . . [on game] legislation . . . final legislation on Alaska lands . . . [and legislation on] threatened and endangered species may offer additional employment opportunities. . . .
>
> Graduates with practical work experience in wildlife or related fields probably will find job opportunities more easily than those without such experience. . . . a more general curriculum may result in acquiring a job more quickly than a degree in a narrowly specialized major.

There were about 20,000 wildlife conservationists in the mid-1970s. Barring some unseen change, employment of wildlife professionals by the mid-1990s may rise only modestly, say, from today's 21,000 to 23,500.

ZOO OR AQUARIUM MANAGEMENT

As a *zoo* or *aquarium manager* you would perform a function in, or direct, one of the approximately 200 zoos and 40 aquariums in the United States. These institutions are playing an increasingly important role in animal and bird conservation and in public education about ecology.

Gary K. Clarke, director of the Topeka, KS Zoological Park, and the Amazon Macaw greet visitors to the tropical rain forest in the zoo's unique "Tropic of Kansas," as Clarke punningly but proudly calls the exhibition building.

Only 40 to 60 percent of the employees of a zoo or aquarium work directly with the animals or fish. In the larger institutions, more than half the employees provide support functions. The chief professional is frequently called director or curator. Every large institution has one or more veterinarians or biologists responsible for the health of the animals or fish. A paraprofessional category of worker is the zoo keeper. Sometimes the larger institution will have a curator of exhibits, art and exhibit supervisor or director of education.

WHAT EDUCATION WOULD YOU NEED TO BE A ZOO OR RELATED-INSTITUTION DIRECTOR?

The director of such an institution usually has a degree in zoology, although it might be in business administration or parks and recreation. Interests in animals and in people are required, as is some practical experience. Gary K. Clarke, whose photo appears here, attended the University of Missouri and majored in zoology. He became director of the Topeka Zoo when he was only 25 and built it within five years to one of the finest medium-size zoos in the nation. He went back to college at Washburn University in Topeka for a degree in management.

The State University of New York at Buffalo has established a graduate program in zoo management, jointly with the Zoological Gardens of Buffalo, believed to be the first in the nation. The veterinarian must have the Doctor of Veterinary Medicine degree, of course. Zoo keepers may have one or more years of college, but mostly they are trained on the job.

WHERE WOULD YOU WORK AS A ZOO OR RELATED-INSTITUTION DIRECTOR?

One good thing about zoos (if you want to volunteer at one) is that they usually are operated by local governments. They must supplement meager tax funds with voluntary contributions, and one way to open their doors to the public is to make maximum use of volunteer help. You can volunteer at around age 16 and perform a variety of chores around the animals. While you probably won't get paid, you will pick up invaluable experience. It could help you get a paying job later.

Once you are accepted as a paid employee, your first duties probably would be as an animal keeper. These jobs are hard to get because they are limited, and competition is keen.

WHAT IS THE JOB FUTURE FOR ZOO OR RELATED-INSTITUTION DIRECTORS?

There are about 7000 total full-time workers in all categories of employment by zoos and aquariums of the United States. There is little turnover and limited promotion from within because many of the animal keepers lack educational and other qualifications for managerial positions.

We would estimate that 2000 of these positions are managerial and professional in stature: directors, managers, curators, and veterinarians. This is a modest increase from 1500 in the mid-1970s. When there is a significant growth factor, such a small field can offer, proportionately, a greater job potential than can a large profession. Such a growth factor is offered by the proliferation of animal parks, theme parks, marine lands, and related commercial attractions, at least one hundred of which are major profit-making enterprises. They have sprung up in recent years, without detracting from the popularity of zoos. Zoos are located mainly in the cities, but proprietary animal parks are located in vacation areas. Zoos are almost always tax-supported and free, whereas animal parks pay taxes and charge admission.

How many jobs there are in zoos and related institutions nobody knows. In the author's studies, he projects that the factors named offer the prospect that all such zoologically oriented attractions may employ twice as many professionals—4000 altogether—by the mid-1990s.

THE EMPLOYMENT IN NATURAL RESOURCES OF PROFESSIONS CONSIDERED EARLIER

The natural resource areas employ, in addition to conservationists and managers, considerable numbers of ecologists, biologists, chemists, civil engineers, and veterinarians, categories which we considered in Chapters 3 and 4. To describe specific

applications of these professions to natural resources would be repetitious. Besides, no one keeps statistics on where professionals work. All of the professions described are *interdisciplinary/integrated/involved*, so as you read about any one, refer backward or forward to others to find their relatedness.

PARAPROFESSIONALS

Natural resources management has about 40 paraprofessional job titles. Included are forest ranger, forestry technician or aide, game warden, park guide, lake manager, and landscape aide. The technician is defined as one who has a certificate from a community college or the equivalent of two years of higher education. As a forestry technician, for example, you might participate in on-the-ground timber sales operations, supervise recreation areas used by the public or perform laboratory experiments and tests for plant diseases. In these positions, you would work under the supervision of a professional.

Censuses are not kept of employment of paraprofessionals, perhaps because so many jobs are part-time and seasonal. However, if you're in college, this area offers potential job possibilities. Be sure to apply in the fall for an opening the next summer. For a local or state job, consult the telephone directory, and call all natural resources agencies listed. To explore a federal job, do the same or write to one of the Agriculture or Interior agencies listed in Appendix D.

WHERE SHOULD YOU WRITE FOR MORE INFORMATION?

American Association of
Zoological Parks and
Aquariums
Oglebay Park
Wheeling, WV 26003

American Fisheries Society
5400 Grosvenor La.
Bethesda, MD 20014

American Society of
Agricultural Engineers
2950 Niles Rd.
St. Joseph, MI 49085

National Recreation and
Park Association
1601 North Kent St.
Arlington, VA 22209

Society for Range Management
2760 West Fifth Ave.
Denver, CO 80204

Society of American Foresters
5400 Grosvenor La.
Bethesda, MD 20014

Soil Conservation Society
of America
7515 N.W. Ankeny Rd.
Ankeny, IA 50021

The Wildlife Society
7101 Wisconsin Ave., NW
Washington, DC 20014

Overleaf: In the Circum-Pacific Map Project, land use specialists are mapping the geologic, mineral, and energy resources of more than half the earth. Photo: U.S. Geological Survey, Department of the Interior.

CHAPTER 6

LAND USE AND HUMAN SETTLEMENTS

What is the use of a house if you haven't got a tolerable planet to put it on?—Henry David Thoreau in 1860

PROFESSIONS COVERED

Architecture	**Landscape Architecture**
Geography	**Planning**

There are some who say that Thoreau lived so long ago that his ideas have become "old-fashioned." They say that we need resources; we need energy; it represents progress to develop the land.

But there are others who say Thoreau was not nearly old-fashioned *enough*, and for a really old-fashioned look at environmental deterioration they cite:

> There are mountains . . which can keep nothing but bees, but which were clothed not so long ago with fine trees, producing timber . . . while the country produced bountiful pastures for cattle. The annual supply of rainfall was not then lost, as it is at present, through being allowed to flow over a denuded surface to the sea.

A segment of narration from a television special on clear-cutting in Oregon, or strip-mining in West Virginia, or suburbanization in Colorado?

No. That passage was written by the philosopher Plato. He was describing the recently destroyed mountainous forest of Greece about 400 years *before* the Christian era began. Today, most of those ancient Mediterranean forests, including the fabled cedars of Lebanon, are gone forever. According to the U.S. Council on Environmental Quality, the land that once was "clothed with fine trees" is in a stable, irremedial state of complete erosion. Many who freely use the word "ecology" do not know that it is derived from the Greek *oikos*, meaning "house," or that house and land are inseparable.

HOW DO WE FEEL ABOUT OUR LAND?

You and I are limited in the ways in which we can express our feelings about many environmental problems. As individuals we can do little about the various forms of pollution except through such collective, indirect actions as the political process. Yet, because the air and water have traditionally been regarded as common goods, the public can arrive at consensus on measures to scrutinize and sanitize those natural resources.

The land is different. We value it more highly than we do the air and water because we think of all the land, with minimal exceptions, as private property. And we feel strongly about the property rights of the individual. "Every man's home is his castle" is one slogan illustrating the property ethic. The American dream has been to own one's own house and lot. The upwardly mobile aspire to a second home, in the mountains, on a lake, or at the shore—for status as well as recreation. Anyone in a cold climate might covet, for vacation or retirement, a cottage in the Sun Belt. Even the dropouts of the 1960s, escaping from urban congestion, high technology, and societal values with which they disagreed, sought out—and frequently squatted on other peoples' private—rural lands. A house is generally the most expensive (and a second

home the second most expensive) purchase a family ever makes.

Real estate, always a sound investment, with rising inflation is becoming sounder all the while. Successful real estate developers have shaped every city and suburb in the land.

Social decisions about land use involve the very fabric of society. Individuals and families, in constant change and frequent move, create impacts on the land of which they are scarcely aware. So do governmental decisions about development, housing, transportation, agriculture, water resources, and the like. So do private industry's various moves—to build a factory, shopping center, power plant, and so forth. Conflicts of many kinds are inevitable in such drastic social change as land use control. Private property vs. public environmental concerns is perhaps the foremost. Economic growth, payrolls, and jobs vs. open land and low density population is another. And environmental protection vs. energy needs is a third. In just one nuclear plant siting, more than 200 persons may be engaged for a year or more just in preparing environmental impact analyses and statements.

So we have conflicting feelings about the land. As we saw in the preceding chapter, we want to preserve much of it for our own and future generations' use and enjoyment. At the same time, we want to be free—and others to be free—to own and use as much of it as we can afford. Yet, there is a finite amount of land. And, although birth rates have declined from the 1945-1959 "baby boom" years, the U.S. population still grows by one to two million per year. What kind of environment our children and their children inhabit is being determined today, to some degree, by such public policies as public housing subsidies, mortgage guarantees, and federal tax provisions favoring home ownership. It is an environment being shaped, as well, by four professions.

ARCHITECTURE

As an *architect*, you would design buildings and the spaces between them. When the American Institute of Architects (A.I.A.)

dedicated a new headquarters building in Washington, D.C., it pledged a rededication of the profession:

> . . . to the fundamental mission of improving the quality of the nation's man-made environment. We pursue this mission in design of works of architecture from individual buildings to entire communities, striving to make them serve both their users and the larger environment of which they are parts. . . . And we pursue this mission as citizens, bending our energies and professional knowledge to the reshaping and renewal of our institutions—social, political and economic—so that a nourishing environment is available to more and more of our fellow citizens.

You would, as an architect, provide a variety of professional services to clients. They could be individuals, organizations, corporations, or government agencies—anybody who needs and can afford a new or remodeled building. Your services would require a variety of skills: design, engineering, finance, cost accounting, managerial, and supervisory. The job could be simple or highly complex, short or extremely long.

First, you often would compete for a commission (an assignment to do a job, based on a contract). Once commissioned, you would meet often with the client to discuss the purposes, requirements, and cost of the project. You would have to listen carefully to the client, trying to understand needs, preferences, tastes, and possibly subconscious desires in connection with the projected building. Ordinarily only then would you prepare a rough drawing to show the scale and structural relationships of the building on its site.

Several preliminary sketches might be necessary before you satisfy the client. Eventually, you complete a final design which shows the floor plans and the structural details of the project. If it is a school, for example, the school board will be concerned that the corridors and stairways are wide enough for mobs of students to rush between classes and safe enough for them to escape in case of fire. They will be concerned that you have provided

for economy of operation and the most energy efficient building possible in your climate zone.

Finally, you would prepare working drawings showing the exact dimensions of every part of the structure and the location of plumbing, heating units, electrical outlets, and air conditioning. And, simultaneously, you would specify the building materials, construction equipment, and, in some cases, interior furnishings. And you would assure that the completed building would conform to local and state building codes, zoning laws, fire regulations, and other ordinances.

You might also assist the client in selecting a contractor and in negotiating the contract. From time to time during construction, you would visit the site. Is the contractor following the design and using the specified materials? You would not relinquish control of the job until the building was finished and had passed all inspections.

In addition to designing homes, office buildings, and factories, you might be responsible for multibuilding complexes, subway systems, college campuses, industrial parks, and new towns. On such large projects, architects may specialize. They often work with other land use and planning professionals, too.

WHAT EDUCATION WOULD YOU NEED TO BE AN ARCHITECT?

Most schools of architecture admit qualified high school graduates who meet the entrance requirements of the college or university with which the school is affiliated. Two to four years of liberal arts may or may not be required. For admission to an architectural program, you should have four years of high school mathematics and English, three years of science, two years of social sciences, and a foreign language, and one year of history. A typical college architectural program includes courses in English, mathematics, chemistry, sociology, economics, and a foreign language, as well as courses in architectural theory, design, graphics, engineering, and urban planning.

There are almost 100 schools of architecture in the U.S. and Canada. Generally you must spend four years in architectural study, leading to a bachelor of architecture or bachelor of environmental design, frequently followed by two years of graduate work leading to a master of architecture or master of environmental design. Some community colleges offer two-year programs in architectural drafting. You can, with an associate in arts from such a program, find employment as an architectural draftperson or transfer to a school of architecture for a professional degree program.

Either as part of the academic curriculum or later, you must gain appropriate practical experience–usually one to three years–under the supervision of a registered architect. After this, you are eligible to take the architectural registration or licensing examination in your state. All states and the District of Columbia require registration because the architect's work directly affects the health, safety, and welfare of the public. State registration is a long accepted way of assuring that you are competent to practice. Once licensed in your home state, you can apply for and receive, reciprocally, a license to practice in any other state without further examination.

WHERE WOULD YOU WORK AS AN ARCHITECT?

As a new graduate, you usually would begin as a junior draftsperson in an architectural firm. Under supervision, you would make drawings and models of structures. You could advance, after several years, to chief or senior draftsperson responsible for all major details of a set of working drawings, and possibly directing the work of others. If you are outstanding, and if the partners of the firm have an opening, they might make you an associate, with clients of your own. Then you would receive, in addition to a salary, a share of the profits. You might, of course, leave your

employer and join with others to form your own architectural firm or establish a private practice alone.

Most architects work for architectural firms or for builders, real estate firms, or other businesses that have large construction programs. Only about 3 percent work for the federal government, primarily for the Departments of Defense, Interior, Housing and Urban Development, and the General Services Administration. Some architecture school graduates who may not have become registered (licensed) work under the supervision of licensed architects.

WHAT IS THE JOB FUTURE FOR ARCHITECTS?

Employment of architects is tied, perhaps more closely than most environmental professions, to cyclical economic conditions such as housing starts and new plant construction. This means that the architect is one of the first professionals to become unemployed or underemployed in a depression.

The young architect, if a product of an education which was *interdisciplinary/integrated/involved*, can readily adapt to economic downturns and compete for related, nonarchitectural jobs. One could, for example, move into graphic design, advertising, visual arts, product design, construction contracting and supervision, and real estate. One could join the Peace Corps or a private philanthropy building housing overseas. Or one could get a job with government or with a consulting firm preparing environmental impact studies and statements.

About 60,000 architects, up from 55,000 in the mid-1970s, practice today. Although projections are riskier in this profession than in most—private employment lacks the job security of government—the author foresees steady growth in demand for architectural graduates. By the mid-1990s, there should be 65,000 employed.

GEOGRAPHY

As a *geographer*, you would work on a wide range of social, economic, political, and environmental problems. You would be concerned with ecology and biology, but not to the degree ecologists and biologists are. You would be concerned with some of the disciplines of environmental health, but not as scientist, physician, or applied environmental protection specialist. You would be concerned with agriculture, all of the areas of conservation, and the distribution of resources and trends in natural resource depletion or renewal. Finally, you would be involved with the other professions of land use and human settlements—architecture, landscape architecture, and planning. So how would you, a geographer, differ from other environmental professions?

The definition given by two professors of geography, Robert Huke of Dartmouth College and Vincent Malmstrom of Middlebury College, in their pamphlet "Geography as a Discipline" is: "Geography is the study of place, or space, in the same sense that history is the study of time." Amplifying that straightforward definition, Salvatore J. Natoli of the Association of American Geographers writes in an AAG booklet: "All the things geographers study depend on two basic criteria—a location and reasons for the location." (Single copies of both publications are free from AAG; see the address at the end of this chapter.)

Geographers could hold other job titles such as *ecologist, industrial developer, land economist, land use planner,* or *urban planner.* The definition and the range of job titles suggest, correctly, that geography is one of the broadest disciplines in environmental science.

As a geographer, you might examine the distribution of landforms; study variations in climate, soils or vegetation; or analyze such resources as water and minerals. As an applied social scientist, you would be concerned with human resources. You might study political organizations, transportation systems, marketing networks, patterns of industrial development, housing, public

health trends, and the interactions of all these factors with the natural and social environment.

You might use advanced statistical techniques, mathematical models, maps, and a computer. In the field, you might interview people, inspect terrain and features of the "built" environment, and take precise measurements with surveying and meteorological instruments. As a member of a research team, you would have available data and observations made by others: maps, aerial photographs, and data compiled by remote sensing instruments on earth satellites and returned to earth by telecommunications facilities.

Most geographers specialize. *Economic geographers* focus on the geographic distribution of economic activities. *Political geographers, urban geographers,* and *regional geographers* help define political boundaries and plan governmental activities. *Physical geographers* study the impacts of the earth's configuration on human and environmental activities. *Cartographers* compile and interpret data, and design and construct maps and charts. *Medical geographers* study the effects of the environment on human health, working with environmental health officials, biostatisticians, and others to project disease trends and to plan epidemiological control methods and health care facilities. Those major specialties within geography can be broken down further into as many, or more, subfields.

WHAT EDUCATION WOULD YOU NEED TO BE A GEOGRAPHER?

About 350 colleges and universities have programs in geography, a surprisingly large number considering that the field is relatively small. (Compare that with forestry, two and one-half times as large, but with only fifty schools offering degrees in forestry.)

A bachelor's degree in geography is the minimum requirement

for beginning positions. Increasingly, however, a master's is essential for a more attractive position. A Ph.D. is required for most teaching, senior research or management positions.

WHERE WOULD YOU WORK AS A GEOGRAPHER?

An estimated 11,000 persons work as geographers, over 50 percent of them in colleges and universities. The federal government is the second largest employer, principally in the Departments of Defense, Interior, Commerce, and Agriculture. Other agencies with significant cadres of geographers are the Environmental Protection Agency, Smithsonian Institution, National Aeronautics and Space Administration, and the Central Intelligence Agency. State and local governments employ others, in the agencies comparable to those named above for the federal establishment.

Magazine and book publishers such as the National Geographic Society employ some geographers, as do the publishers who produce maps including the oil companies' road maps, geologists' maps and atlases. Increasingly, consulting engineering and management firms hire geographers.

WHAT IS THE JOB FUTURE FOR GEOGRAPHERS?

The Bureau of Labor Statistics sees little or no employment growth in colleges and universities. But it is optimistic about opportunities in urban and environmental management and planning, including location analysis, land and water resources management, and environmental health planning. "Those with strong backgrounds in urban, economic, and physical geography and in quantitative techniques should be in particular demand," says the BLS, adding:

> The Federal Government will need additional personnel to work in programs such as health planning, regional development, environmental quality, and intelligence. Employment of geographers in state and local government is expected to expand, particularly in health planning; conservation; environmental quality; highway planning; and city, community and regional planning and development. Private industry is expected to hire increasing numbers of geographers for market research and location analysis.

About 10,000 geographers were identified in the mid-1970s, and there are some 11,000 now. In view of the range of activities into which geographers can move, the author shares the BLS's optimism about the non-teaching half of the vocation. By the mid-1990s, we expect some 12,000 geographers to be employed in professional positions in the United States.

LANDSCAPE ARCHITECTURE

As a *landscape architect*, you would be responsible for planning, designing, and supervising the development of outdoor areas for people to use and enjoy. You would be following in the footsteps of Frederick Law Olmsted, the father of American landscape architecture. A century ago he designed New York City's Central Park. The goal of today's landscape architect is the same as that of Olmsted: to make the world more livable and life more satisfying and meaningful.

You might assist a real estate firm starting a new suburban development, a city building an airport or a regional planning commission developing a land use plan. When you are given the landscaping responsibility early—that is, before excavation, grading, and construction have been started—you can avoid the land damage which so often results from arbitrarily denuding the site of trees and natural cover.

When you began a project you would analyze its nature and purpose, the funds available, and the various types of buildings

planned. You would study the site itself, observing, photographing, and mapping such features as the slope of the land and the position of existing buildings and trees. You would consider the parts of the site which would be sunny or shady at different times of the day and at different seasons; the structure of the soil; existing utilities; and many other factors affecting a landscape's design. After consulting with the client and any other professionals involved such as the engineer and the architect, you would prepare a plan. If the plan were approved by the client, you next would prepare working drawings showing existing and proposed details such as buildings, roads, signs, utilities, walkways, terraces, unique natural or historical features, trees, grading, and drainage characteristics. You would be concerned with preserving as much of the site undisturbed as possible.

You would be partially responsible for the aesthetic values of the final result: you as well as the client and the architect would want it to be a community asset and, possibly, win an award for environmental design. You also would be concerned with the population and traffic density. If possible and appropriate to provide resting places for people, picnic tables, a garden or bicycle and bridle trails, you would sketch them in on drawings early. With the architect and engineer, you would draw up preliminary plans. You probably would make lists of building materials, determine specifications, and invite landscape contractors to bid for the work. The client should have imposed limitations on costs, so you would be concerned with the economics of getting the job done.

You might specialize in a single type of facility: parks and playgrounds, campuses, hotels and resorts, hospitals, country clubs, shopping centers, roadways, urban redevelopment, etc. Or you might be a generalist, sometimes designing each of those facilities.

Today, the landscape architect has a new function: planting for energy conservation. Too often, when we think of solar energy, we think of engineering and constructing large collectors of solar heat. The sun's rays warm water or some other liquid which, in turn, is pumped to a storage tank. From there, it is pumped through pipes for use as hot water or for space heating.

All of that effort consumes energy in the form of electricity, usually from fossil fuels. This is called ***active solar heating***, and it consumes less electricity, oil or natural gas than any other form of heating and cooling except *passive solar*.

The landscape architect is the foremost authority on, and practitioner of, passive solar—literally, energy conservation. It is defined as the siting of buildings, and their shading with overhangs, trees, and shrubbery, so that they receive maximum sun in winter and minimum in summer. The client hires the landscape architect to beautify the surroundings; energy conservation is a free dividend. The energy saved, and the reduction in heating-cooling bills, also is free for the life of the building.

WHAT EDUCATION WOULD YOU NEED TO BE A LANDSCAPE ARCHITECT?

A bachelor's degree in landscape architecture, which takes four or five years, is the minimum educational requirement for entering the profession. About 100 colleges offer programs, approximately half of which are accredited by the American Society of Landscape Architects.

Most schools advise the high school student to take courses in art, botany, and more mathematics than the minimum required for college entrance. Some also require a high school course in mechanical or geometrical drawing. Otherwise, the requirements for admission are similar to those for architecture, engineering, or science. College technical courses would include surveying, landscape and architectural design, landscape construction, plant materials and design, sketching, recreation and city planning, contracts, specifications, cost estimates, and business practices. You should especially enjoy the field trips, and if you are fortunate, you may get some practical job experience while still in college.

Thirty-eight states require a license, based on the results of a uniform national licensing examination, for independent practice of landscape architecture.

WHERE WOULD YOU WORK AS A LANDSCAPE ARCHITECT?

Virtually all landscape architects are in the private sector, working in their own, usually small, businesses, or for architectural, landscaping or engineering firms. Others are employed by government agencies concerned with forest management, water storage, public housing, city planning, urban renewal, highways, parks, recreation, or energy conservation. Fewer than 1,000 work for the federal government, mainly in the Departments of Agriculture, Defense, Energy, and Interior.

WHAT IS THE JOB FUTURE FOR LANDSCAPE ARCHITECTS?

The Bureau of Labor Statistics expects employment of landscape architects to grow faster than the average for all occupations. The environmental and energy conservation movements will provide most of this thrust. Landscape architects will continue to be in demand for planning and designing attractive suburbs and shopping centers. Local ordinances are tightening up requirements for beautifying office parks, medical clinics, schools, hospitals and other such developments. Companies are compelled by public relations, if not zoning regulations, to make headquarters, plants, and local offices conform to high standards of landscaping. Utilities use landscaping to camouflage power stations. Legislation requires the participation of landscape architects in hiding unsightly businesses such as junkyards, in planning transportation systems, outdoor recreation areas, industrial parks, and the like. Finally, federal legislation mandates the reclamation of strip-mined lands, the preservation of historic areas and facilities, and coastal zone management—in all of which the landscape architect has a key role.

The latest census of landscape architects shows about 15,000 practicing, up from 12,000 in the mid-1970s. The author

foresees steady growth in demand through the mid-1990s, when employment of landscape architects should reach 18,000.

PLANNING

As a *planner*–sometimes called a *city* or *urban planner, regional planner* or *planning official*–you would develop programs to provide for future growth and revitalization of a city, group of cities, region or other political jurisdiction. You would be responsible for implementing local and state land use control laws.

Be prepared, for the life of a planner is not easy: You would often be trapped between virtually irresistible pressures or temptations (even bribery) and immovable obstacles (factories or communities improperly located before planning was considered). You would find that feelings run deeply and tempers fray easily. Citizen groups and the media could be critical of your activities and decisions. Many people have conflicting values–environmentalists who want to preserve amenities, for example, or city fathers who want to rezone from single family dwellings to high-rises for the increased revenues. It would be your job to figure out the costs vs. the benefits of permitting, controlling or forbidding development. You also could be responsible for persuading citizens and political bodies of the wisdom or justice of your perhaps controversial recommendations.

For example, if your wealthy suburban county were faced with the problem of running out of space for its sanitary landfill, you might find perhaps a dozen sites for replacement which theoretically were suitable. But then hearings would be held–and the neighbors near each proposed location would object vociferously. They might threaten to vote the county leaders out of office at the next election, and while you were a tenured civil servant not an elected official, you would feel the warmth of the electorate's wishes because you report to the county council. The decision is, by law, a political one, and the county council rarely would take a course strenuously opposed by the people. The

council would turn down all your recommendations and instruct you to look further.

WHAT EDUCATION WOULD YOU NEED TO BE A PLANNER?

A bachelor's degree in almost any liberal arts or environmental studies curriculum would qualify you for a beginning job in planning. Economics, marketing, statistics, and management might substitute. A degree in geography, conservation, recreation, or ecology would be excellent. Some colleges offer bachelor's work in planning, frequently under other disciplinary names.

About sixty colleges and universities offer a master's degree in urban planning. With a bachelor's degree in architecture or engineering, you might complete the planning master's in one year; normally the program would require two or three years.

WHERE WOULD YOU WORK AS A PLANNER?

Most planners work for city, county or regional planning agencies. With this exception—the majority in public, rather than private, employment—the other statements above for landscape architects apply, as well, for planners.

WHAT IS THE JOB FUTURE FOR PLANNERS?

All of the statements above for landscape architects apply, as well, for planners. Only the perspective would differ. As a planner, you would look at community or regional problems from the standpoint of a public servant, and your clients would be the

taxpayers. Present employment is about 14,000, up from 11,000 in the mid-1970s. The author foresees steady growth in demand through the mid-1990s, when employment of planners should reach 16,000.

THE EMPLOYMENT IN LAND USE AND HUMAN SETTLEMENTS OF PROFESSIONALS CONSIDERED EARLIER

The land use and human settlements areas employ, in addition to architects, geographers, landscape architects, and planners, considerable numbers of ecologists, biologists, civil engineers, conservationists, and recreationists. We considered those categories of professions in Chapters 3, 4, and 5.

WHERE SHOULD YOU WRITE FOR MORE INFORMATION?

American Institute
of Architects
1735 New York Ave., NW
Washington, DC 20006

American Society
of Landscape Architects
1900 M St., NW
Washington, DC 20036

American Institute
of Planners
1776 Massachusetts Ave., NW
Washington, DC 20036

Association of American
Geographers
1710 16th St., NW
Washington, DC 20009

Overleaf: Maureen Hinkle, a political science graduate of Wellesley College, covers Capitol Hill, the Environmental Protection Agency, and many other bases as pesticides monitor in the Washington office of the Environmental Defense Fund (EDF). Photo: Marcia Fine Sillcox.

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CHAPTER 7

"THE ENVIRONMENTAL MOVEMENT IS A TIDAL WAVE"

> You may hear that the environmental movement is over. That is not so, and those who believe it are in for a rude awakening. The environmental movement is a tidal wave, not just in the United States, but all over the world!—Jacques-Yves Cousteau

Such exuberance comes naturally to the great French ocean scientist and communicator Jacques-Yves Cousteau. In addressing the American Oceanic Organization in Washington, DC he made the remark to convey two concepts: *speed* and *power*.

The environmental movement is, indeed, unprecedented in the speed with which it developed. Even if you, the reader, are still in your teens, you may be older than the environmental movement.

The tidal wave itself, the beginning of the new environmentalism, dates from Earth Day in April 1970. No innovation of its scope has ever moved so far, so fast. Compare it to another revolutionary idea, the automobile. (Remember that we referred in Chapter 1 to the automobile as characterizing our modern, high-technology society at its best, and at its worst.) The first steam-powered automotive vehicles were introduced around 1800. Still, autos did not become cheap enough for the average person to own one until assembly line methods made possible mass production of cars, around 1900. The introduction of the automobile took a full century!

The tidal wave we call the new environmentalism also is unprecedented in its *power*—in the changes it has made in policy, public opinion, economic expenditures, and even in our systems of social values and political priorities.

The American people are willing to pay the price for environmental quality; scores of public opinion polls have documented that fact. We are deeply concerned about the presence of toxic chemicals in our environment. We much prefer safe forms of energy, such as conservation and solar energy, to sources that pose health risks and other dangers. And we are more concerned about the possible risks of living near nuclear power plants and hazardous waste dumps than we are about living near power plants fired by coal. We still care very much about saving endangered species and protecting our fragile wetlands. We insist upon environmental protection and are willing to pay more for goods and services produced and delivered in accordance with environmental regulations. Even when critical issues of energy supply are concerned, most consumers insist on a balance with environmental considerations. Environmentalists have demonstrated the political strength to achieve great goals such as what they wanted with respect to Alaska lands. Now we face greater challenges than ever before in toxic substances and hazardous wastes, land use, the impact of carbon dioxide increase on world climate, and the long-range threat of acid rain destroying fresh-water recreation, soil productivity, and forest industries.

The Council on Environmental Quality estimates that we will spend, between now and the mid-1990s, more than half a trillion dollars in public and private funds to achieve environmental goals. This third edition of *Opportunities in Environmental Careers* is expressly focused on the impact of such expenditures on the employment of environmental managers. In the Preface we said, "With the possible exception of energy, no field is more avidly seeking qualified personnel today than some professions of environmental management. It appears that this trend will continue for at least another decade." Elsewhere in these pages we explored a variety of environmental studies programs at a range of colleges and universities. And we mapped the routes which could lead to exciting new environmental horizons for you. Finally, we examined two periods for which environmental employment is reasonably well established—the mid-1970s and the

mid-1980s—and projected present trends into the future, namely to the mid-1990s. Where we are coming from, where we are now, and where we are going, with respect to environmental jobs, is shown in summary in the following table.

The table shows that the thirty-one professions and paraprofessions in four major environmental fields covered in this book now employ (by the author's estimate) 1,774,500 persons in full-time (or equivalent) permanent jobs. He projects that the same professions and paraprofessions will grow, by the mid-1990s, to employ 2,097,500 persons.*

We use the estimates and projections of the Bureau of Labor Statistics wherever available. But in at least half of the categories covered here the BLS either does not report employment or does not break it down so that the environmental portion can be identified. In those instances, the author uses professional association estimates—or lacking those, his own.

We also accept the bureau's general assumptions, which are:

- Inflation will decelerate to about 5 percent annually after the early 1990s.
- A stable, long-run unemployment rate close to 4.5 percent will pertain in the early 1990s.
- Higher energy prices will not constrain growth in the gross national product (GNP).
- The institutional framework of the U.S. economy will not change radically.
- Current social, technological, and scientific trends will continue.
- No major disturbance or disaster such as widespread or long-lasting energy shortages or war will occur to alter significantly the industrial structure of the economy or to alter the rate of economic growth.

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*As the total work force is expected to be 120 million by the mid-1990s, the *environmental component* will be 1.75 percent of the total.

Table 7.1. Environmental Professional and Paraprofessional Jobs: Estimates and Projections Over Two Decades

Profession *Discipline*	Employed *Mid-1970s*	Employed *Mid-1980s*	Projected *Mid-1990s*
Ecology	5,000	7,500	10,000
Biology	75,000	100,000	125,000
Paraprofessionals	75,000	100,000	125,000
Chemistry			
Biochemistry	8,000	10,000	20,000
Chemical Engineering	4,000	5,000	8,000
Chemistry	60,000	70,000	80,000
Paraprofessionals	72,000	85,000	108,000
CHAPTER 3 TOTALS			
The Sciences of Living Things	299,000	377,500	476,000
Environmental Engineering	10,000	20,000	30,000
Environmental Health Scien.	20,000	28,000	34,000
Environmental Medicine			
Environmental Medicine	4,000	6,000	8,000
Environmental Nursing	4,000	7,000	10,000
Pub. Heal. Veterinary Med.	2,000	3,000	4,000
Environmental Sanitation	20,000	35,000	45,000
Health Physics	2,000	4,000	6,000
Industrial Hygiene	2,000	4,000	6,000
Categorical Specialists	50,000	100,000	110,000
Paraprofessionals	320,000	640,000	750,000
CHAPTER 4 TOTALS			
Environmental Health	434,000	847,000	1,003,000

Table 7.1. Environmental Professional and Paraprofessional Jobs: Estimates and Projections Over Two Decades

Profession *Discipline*	Employed *Mid-1970s*	Employed *Mid-1980s*	Projected *Mid-1990s*
Agricultural Sciences	50,000	75,000	100,000
Fisheries Conservation	14,000	15,000	17,500
Forestry	24,000	25,000	27,500
Forest Technology	10,000	13,000	15,000
Range Management	3,500	4,000	5,000
Recreation	250,000	275,000	290,000
Soil Conservation	12,000	14,000	18,000
Soil Science	5,000	6,000	7,000
Wildlife Conservation	20,000	21,000	23,500
Zoo or Aquarium Management	1,500	2,000	4,000
CHAPTER 5 TOTALS Resources and Recreation	390,000	450,000	507,500
Architecture	55,000	60,000	65,000
Geography	10,000	11,000	12,000
Landscape Architecture	12,000	15,000	18,000
Planning	11,000	14,000	16,000
CHAPTER 6 TOTALS Land Use and Human Settlements	88,000	100,000	111,000
GRAND TOTALS, FOUR FIELDS	1,211,000	1,774,500	2,097,500
	Employed *Mid-1970s*	Employed *Mid-1980s*	Projected *Mid-1990s*

Source: Odom Fanning © Copyright 1981 by Odom Fanning

Table 7.2. Environmental Generalists: A Checklist

Administrator: Federal state, local government, corporate, voluntary organization	Historian
Artist	Historic preservationist
Citizen activist	Journalist
Computer specialist	Lawyer
Conservator	Legislator: Federal, state, local
Consultant	Librarian
Consumer affairs specialist	Mediator
Economist	Owner of business
Educator (at any level)	Photographer
Energy impact assessor	Political scientist
Environmental impact assessor	Population researcher
	Psychologist
	Sales and marketing executive
	Statistician

All well and good, you may be saying:

> I'm a new environmentalist, but I have no interest in becoming a scientist, engineer or technician. I am a generalist. Will there be a job for me over this environmental career horizon?

Certainly! The author believes, with Cousteau, that the environmental movement *is* a tidal wave. Table 7.2 is a checklist of jobs for environmental generalists. No figures are available on jobs, present or potential, for generalists. All we know is that some jobs are there. Find the area that interests you. Good luck, and Happy Earth Days for years ahead!

APPENDIX A

DIRECTORIES AND HANDBOOKS

Career Opportunities in Art Museums, Zoos, and Other Interesting Places, published by the U.S. Department of Labor and available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. (GPO)

Compensation in the Fields of Fish and Wildlife Management, published by the National Wildlife Federation, 1412 16th St., NW, Washington, DC 20036. (NWF)

Conservation Directory. (NWF)

Environmental Protection Careers Guidebook, published by the U.S. Department of Labor and U.S. Environmental Protection Agency. (GPO)

Environmental Quality: The Annual Report of the Council on Environmental Quality. (GPO)

Health Careers Guidebook, published by the U.S. Department of Labor and U.S. Department of Health and Human Resources. (GPO).

Occupational Outlook Handbook, published by the U.S. Department of Labor. (GPO)

APPENDIX B

CITIZEN ORGANIZATIONS AND THEIR PUBLICATIONS

The American Forestry Association, 1319 18th St., NW, Washington, DC 20036. Publication: *American Forests*

The American Museum of Natural History, Central Park West at 79th St., New York, NY 10024. Publication: *Natural History Magazine*

The Cousteau Society, 777 Third Ave., New York, NY 10017. Publication: *Calypso Log*

Defenders of Wildlife, 1244 19th St., NW, Washington, DC 20036. Publication: *Defenders*

Environmental Action, Room 731, 1346 Connecticut Ave., NW, Washington, DC 20036. Publication: *Environmental Action*

Environmental Defense Fund, 475 Park Avenue South, New York, NY 10016. Publication: *EDF Letter*

Friends of the Earth, 124 Spear St., San Francisco, CA 94105. Publication: *Not Man Apart*

The Izaak Walton League of America, 1800 North Kent St., Suite 806, Arlington, VA 22209. Publication: *Outdoor America*

National Audubon Society, 950 Third Ave., New York, NY 10022. Publication: *Audubon*

National Geographic Society, 17th and M Sts., NW, Washington, DC 20036. Publication: *National Geographic*

National Parks & Conservation Association, 1701 18th St., NW, Washington, DC 20009. Publication: *National Parks & Conservation Magazine*

National Wildlife Federation, 1412 16th St., NW, Washington, DC 20036. Publications: *National Wildlife, International Wildlife*

National Resources Defense Council, 122 East 42nd St., New York, NY 10017. Publication: *The Amicus Journal*

The Nature Conservancy, Suite 800, 1800 North Kent St., Arlington, VA 22209. Publication: *The Nature Conservancy News*

Public Lands Institute, 1740 High St., Denver, CO 80218

Rachel Carson Council, 8940 Jones Mill Rd., Washington, DC 20015

Sierra Club, 530 Bush St., San Francisco, CA 94108. Publication: *Sierra*

Smithsonian Institution, 1000 Jefferson Dr., SW, Washington, DC 20560. Publication: *Smithsonian*

The Wilderness Society, 1901 Pennsylvania Ave., NW, Washington, DC 20006. Publication: *The Living Wilderness*

World Wildlife Fund-U.S., 1601 Connecticut Ave., NW, Suite 800, Washington, DC 20009

APPENDIX C

OTHER ENVIRONMENTAL PUBLICATIONS

BioScience, American Institute of Biological Sciences, 1401 Wilson Blvd., Arlington, VA 22209

Catalyst for Environment/Energy, 274 Madison Ave., New York, NY 10016

Conservation Foundation Letter, 1717 Massachusetts Ave., NW, Washington, DC 20036

Environment, Heldref Publications, 4000 Albemarle St., NW, Suite 504, Washington, DC 20016

In Business, the J G Press, Box 323, Emmaus, PA 18049

The Journal of Environmental Education, Heldref Publications, 4000 Albemarle St., NW, Suite 504, Washington, DC 20016

Environmental Education Report, 2100 M St., NW, Suite 307, Washington, DC 20037

Environmental Ethics, Department of Philosophy and Religion, University of Georgia, Athens, GA 30602

Environmental Science & Technology, the American Chemical Society, 1155 16th St., NW, Washington, DC 20036

EPA Journal, Environmental Protection Agency, Washington, DC 20460

The Futurist, World Future Society, 4916 St. Elmo St., Bethesda, MD 20014

Nature Canada, Canadian Nature Federation, 46 Elgin St., Ottawa, Canada K1P 5K6

APPENDIX D

KEY FEDERAL AGENCIES

Comprehensive Sources of Federal Job and Program Information

General Services Administration, Washington, DC 20405
GSA's Federal Information Centers located in many cities can be reached on toll-free telephone numbers and will provide answers to any questions

Consumer Information Service, Pueblo, CO 81009

Office of Personnel Management, Washington, DC 20415
This office, formerly the Civil Service Commission, is directly responsible for federal employment

Major Agencies Employing Environmentalists (Or Publishing Environmental Data)

ACTION, Washington, DC 20525
Peace Corps, VISTA

Department of Agriculture, Washington, DC 20250
Forest Service; Science and Education Administration; Soil Conservation Service

Department of Commerce, Washington, DC 20230
National Oceanic and Atmospheric Administration, Rockville, MD 20852

Congress of the United States, Washington, DC 20510
Office of Technology Assessment

Consumer Product Safety Commission, Washington, DC 20207

Council on Environmental Quality, Washington, DC 20006
Department of Defense, Washington, DC 20301
Department of Education, Washington, DC 20202
  Office of Environmental Education
Department of Energy, Washington, DC 20585
Environment Canada, Ottawa, Ontario, Canada K1A OH3
Environmental Protection Agency, Washington, DC 20460
  Environmental Research Center, National Training and Operational Technology Center, Cincinnati, OH 45268
  Environmental Research Laboratory, Research Triangle Park, NC 22709
Federal Emergency Management Agency, Washington, DC 20472
Department of Health and Human Services, Washington, DC 20201
  Centers for Disease Control, Atlanta, GA 30333
    National Institute for Occupational Safety and Health, Rockville, MD 20857
  Food and Drug Administration, Rockville, MD 20857
  National Institutes of Health, Bethesda, MD 20205
    National Institute of Environmental Health Sciences, Research Triangle Park, NC 22709
Department of Housing and Urban Development, Washington, DC 20410
Department of the Interior, Washington, DC 20240
  Fish and Wildlife Service
  National Park Service
Department of Labor, Washington, DC 20210
  Bureau of Labor Statistics; Occupational Safety and Health Administration
National Aeronautics and Space Administration, Washington, DC 20546
National Science Foundation, Washington, DC 20550
Nuclear Regulatory Commission, Washington, DC 20555
Smithsonian Institution, Washington, DC 20560
Department of Transportation, Washington, DC 20590
Veterans Administration, Washington, DC 20420

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